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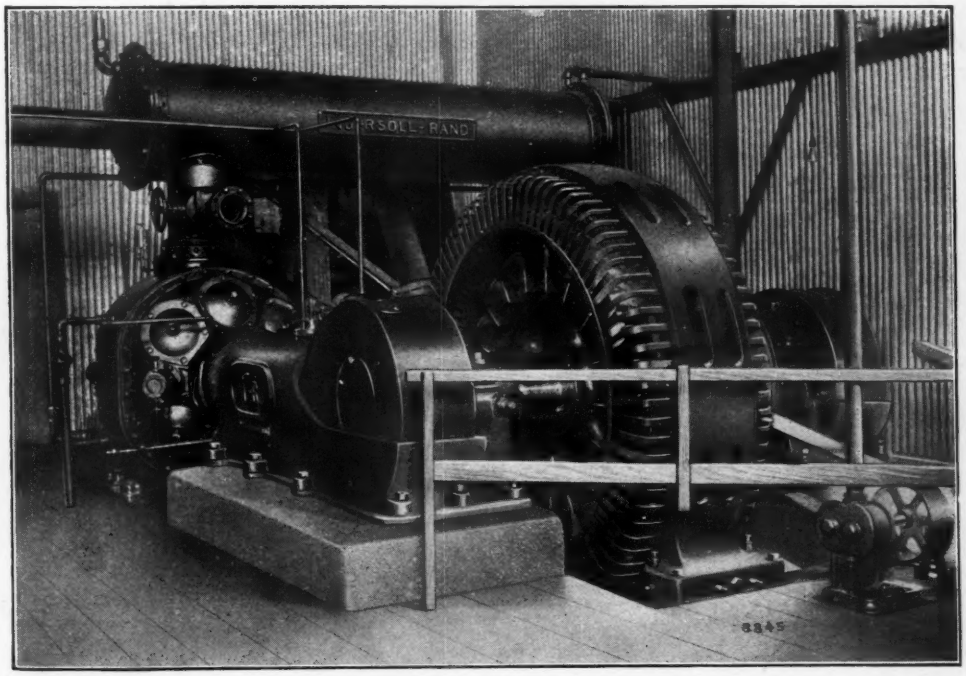
COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. XXI MAY, 1916. No. 5

"Ingersoll-Rogler" "PRE" Power Rogler Electric Air Compressors



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Installed by the Cresson Consolidated Gold Mining Co., Cripple Creek, Colo.
This type is described in new Bulletin No. 3026.

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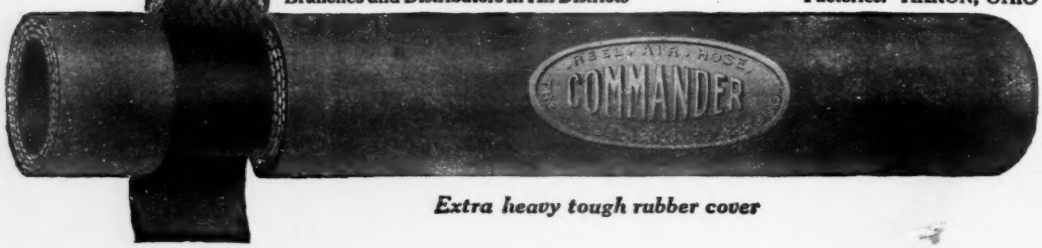

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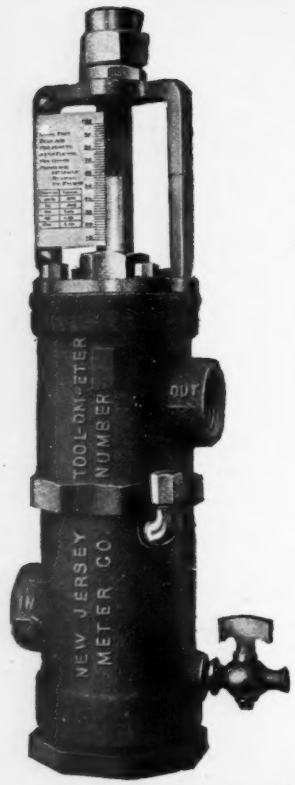

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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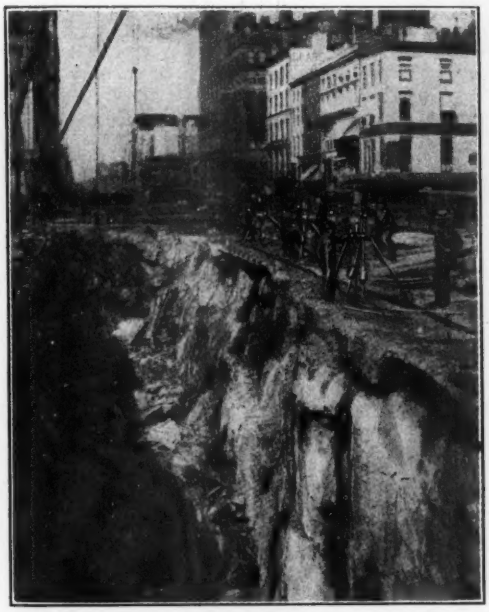


FIG. 1.

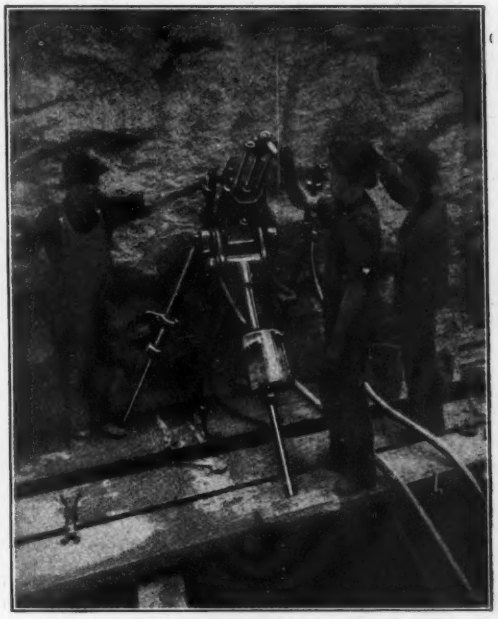


FIG. 2.

SUBWAY EXCAVATING REVOLUTIONIZED

BY CHAS. A. HIRSCHBERG.

It is not a far cry in time, from the completion of the existing Broadway and Fourth avenue subways of Manhattan, New York, to the commencement of work on the new subway extensions, on Seventh avenue, Lexington avenue, etc., of the present day. To be exact, but slightly over 10 years have elapsed.

In this short space of time many changes have taken place, not so much in the general design of the subway itself, but in the means and methods employed for doing the work.

The island of Manhattan is a rocky ridge of gneiss and mica schist formation, with heavy seams of coarse-grained dolomitic marble and thinner layers of serpentine running through it, requiring the employment of rock drilling machinery and explosives for its removal.

In part the work consists of open cuts, calling for the drilling of down holes not unlike the methods employed in crushed rock quarry

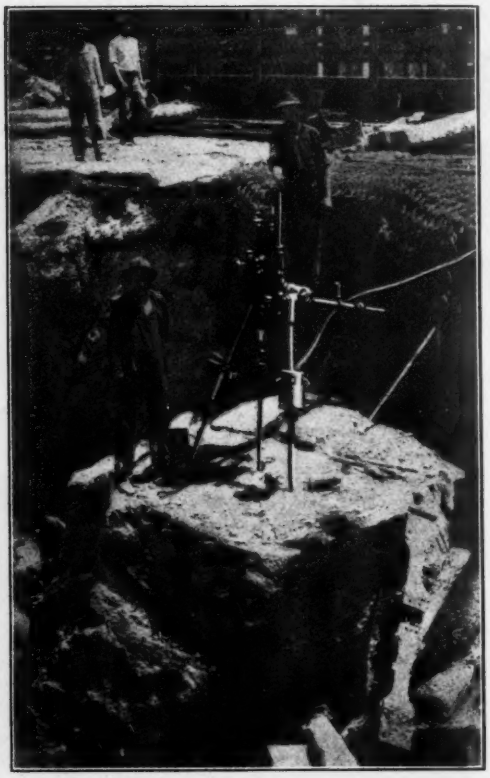


FIG. 3.

excavation, with the break confined, however, to predetermined restricted dimensions. Through congested traffic quarters, the work is prosecuted by using heading tunneling methods and where the capping is light the excavation kept covered to permit traffic to progress overhead.

The surprising dissimilarity between the past and present subway work is mainly found in the employment of rock drilling machinery, of such a radically different character, and possessing such obvious advantages over former equipment, that we are led to wonder at the accomplishments of the past.

It is to be remembered that the rock drills here to be spoken of, both the ancient and the modern, if we may so characterize them, are all driven by compressed air.

Fig. 1 depicts an open excavation proceeding on the old Fourth avenue subway, between Sixteenth and Seventeenth streets, with tripod drills weighing complete in the neighborhood of 500 to 600 lbs., and requiring from 2 to 3 men for their operation. In fact, the illustration clearly shows that three men comprised each drill crew.

Attention is called to the row of drilled holes, indicated by the wooden plugs. These holes, as will be noted, were put down at intervals of about 2 ft. and regularly spaced as to alignment. In spite of this, the break is decidedly irregular, as can be seen by examining the excavated portion. As a result trimming on side walls became necessary and this cost money and consumed time, especially as the trimming had to be done with the same type of heavy drilling machine, rigged up as best it could be done on scaffolding and other structures as will be noted in Fig. 2.

This was not the only extra expense to which the contractor was put by his drilling equipment. The rock often broke too large for handling and redrilling became necessary,

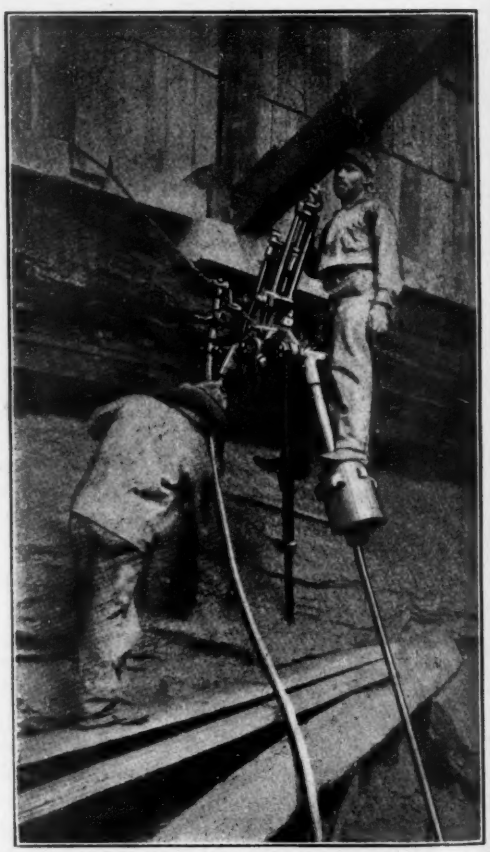


FIG. 4.

FIG. 5.

as shown in Fig. 3, and each time a drill was moved and set up, the derrick had to be employed and from 30 to 60 minutes lost rigging up.

The question naturally arises: Why weren't the holes drilled more closely together in the initial work to obtain better breaking effect? With the heavy tripod drill universally in use at that time, it was found to cost less to do the subsequent work of trimming and breaking than move the equipment frequently enough for close drilling. The holes were of fairly large diameter, generally starting at 2¾ to 2½ ins. and bottomed 1½ to 1¾ ins., using 2-ft. changes of steel. The holes were also drilled deep to avoid the cost of resetting the drilling equipment had shallow holes prevailed. Holes of the diameter named required time for their drilling, and necessitated using heavy steels and it cost time to change steels, loosening and tightening chuck bolts. These heavy steels had to be hand-sharpened, a slow process, and an uncertain one, owing to the class of labor available. The bits did not always follow, due to the irregularity of the hand-made bit and gauge. The method of drilling

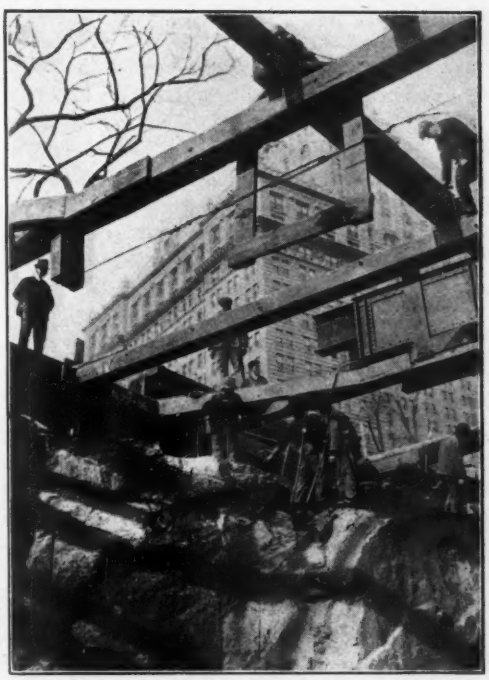


FIG. 6.

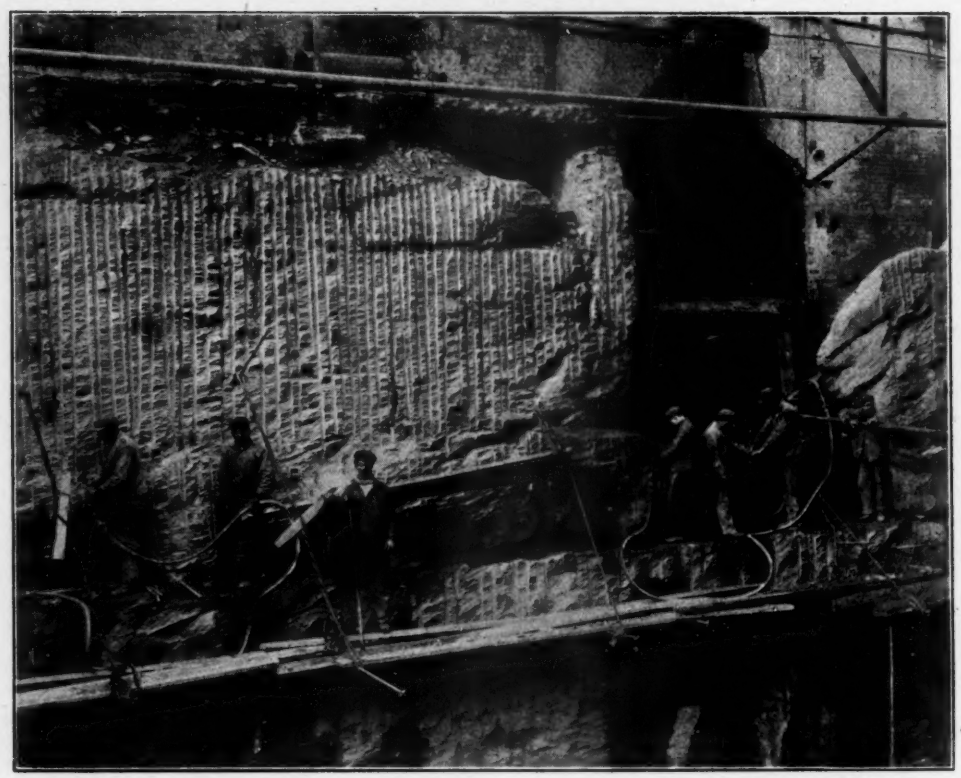


FIG. 7.

followed was found on the whole to be the least of several evils.

Fig. 4 shows a tripod drill at work in the shaft which was sunk at Forty-first street and Park avenue. The cumbersomeness of the equipment is at once apparent—it led to uncertain breaking, the use of scaffolding and a labor expense multiplied by 2 and often by 3.

Fig. 5 shows a breast in one of the tunnels. Large tools require large mountings, limit the placing of holes and the result is costly subsequent work.

A progress of 80 to 100 ft. of drill hole per day, in open excavation work, per tripod drill, employing 2 to 3 men, was considered good, and it was good at that time.

Likewise in tunnel work, where several holes could be drilled from an initial set-up, a drill hole footage of 90 to 120 ft. generally prevailed, while in shaft work the rate of drilling was somewhat lower than that with open cut work, owing to the necessity for more careful placing of holes and the interference of the spoil from previous blasts.

Let us examine the methods and equipment of today.

FIG. 8.

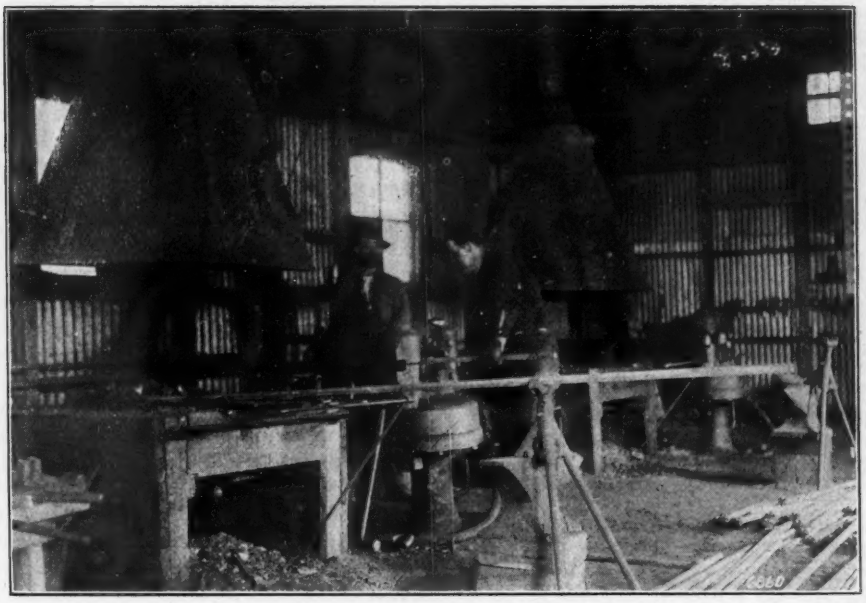


FIG. 9.

In Fig. 6 is shown an open cut excavation on the Seventh avenue subway at the Battery. Small 40-lb. hand-held, and practically self-operating drills, have replaced the heavy drills and their tripods. But one man, is employed in place of two or three, and he is having a comparatively easy time; in fact, he might almost be accused of loafing. There is no crank to turn, the machine rotates the steel for him. There are no chuck bolts to bother with—the steel rests loosely in the machine. Its light weight permits of quick shifting, and its small size enables it to work in restricted places, where you could not set a tripod without special rigging.

As a result holes are spaced closely together and the break is clean. While it is true that occasionally there is trimming to be done, it is accomplished so much more quickly, easily and cheaply that it scarely enters into consideration.

Fig. 7 shows a section of side wall. The spacing of the drill holes and the cleanliness of the break are clearly indicated.

The average drilling progress is in the neighborhood of 120 to 150 ft. per drill, per day, accomplished with but one man and in the place of a few machines, as in the case of the tripod drill, the job swarms with them, expediting greatly all operations.

The size of hole drilled generally bottoms 1¼ ins. employing starters of 1¾ ins.

Fig. 8 shows a shaft sinking view. Here again is a demonstration of clean breaking, a direct result of the type of drilling machine. Holes can be placed where the best breaking effect will result. A greater number of drills can be operated and the shaft sunk in much less time. Drilling and mucking proceed simultaneously, and there is no delay. Stops are only made to permit blasting, when the equipment is removed and returned with a minimum loss of time.

One contractor who has had experience in shaft sinking with both classes of drills gives the following basis of comparison:

Size of shaft.....15x16 ft.
No. of drills used.....2 Jackhamers.
Character of ground.....Hard.
No. of shifts per day.....3 8-hr.
Total time.....4 months.
Total depth sunk.....359 ft.
Average progress per month..89.75 ft.

Best previous record made in shaft sinking with tripod drills by this contractor, under very similar working conditions was 61 ft. per month.

On working where tunneling methods are necessary a decided increase in progress is also to be noted. A drill hole footage of 120 to 150 ft. per day is not uncommon.

With the advent of these light rock drilling machines came the drill steel machine sharpener shown at work in Fig. 9. In this particular installation the operator turns out an average of 60 cross bits per hour from the blank on 1-in. hollow hexagon steel. The resharpening of drill steel is considerably faster.

The bit is of a superior character to the hand-sharpened bit, being true to gauge and practically perfect in form. The result is added drilling speed to an already rapid drilling equipment.—*Min. and Eng. World.*

STUDY OF MACHINE DRILLING AT TREADWELL MINES, ALASKA

BY E. P. KENNEDY

For years the standard machine drill in use in the Treadwell mines (the Treadwell, Mexican, 700 and the Ready Bullion mines, all of which are connected by underground workings and are under the one management) was the Ingersoll-Sergeant piston machine. Two sizes were in use—the 3¼ and the 3⅝-in. machines. Shaft sinking was done exclusively with the larger machines, which were also used in the open pits.

In the openpits, holes were drilled 12 ft. deep, approximately vertical, with a set of steel consisting of six drills. No openpit work was done after the year 1907. Holes underground were drilled approximately 7 ft. deep and a standard set of steel prior to 1908 for underground use in the Treadwell mines is described in the following tabulation:

	—Shank End—		—Bit End—		—Drill—		
No.	Length, In.	Size Oct. In.	Length, In.	Size Cru. In.	Length, Ft.	Length, In.	Gage, In.
1	18	1¼	18	1¾	3	..	2¾
2	44	1¼	14	1¾	4	10	2½
3	66	1¼	14	1¾	6	8	2¼
4	88	1⅛	14	1½	8	6	2

The set of steel weighs approximately 110 lb. and was made up by contract at a cost of 35c a drill for labor only, to which should be added the cost of coal or oil, borax and steel wasted in welding. The chucks of the machines to receive the drills were fitted with octagon bushings to receive the 1¼-in. octagon drill shank, and the 1⅛-in. shank of the No. 4 drill was upset to 1¼-in. size.

In January, 1908, I had a machine fitted up with a cruciform bushing to receive 1½-in. cruciform steel and had sets of steel made up as follows:

No.	Length, Ft.	Length, In.	Dia. Cru., In.	Gage, In.
1	3	..	1½	2¼
2	4	10	1½	2
3	6	8	1⅜	1¾
4	8	6	1¼	1½

An extended trial with this machine proved conclusively the advantage of changing, and as rapidly as it could be economically done, all piston machines were fitted with cruciform bushings and the old steel gradually replaced by the new drills. The change of gage reduced the amount of material to be cut in drilling a hole by 37 per cent., and the change to all cruciform steel obviated welding and also reduced the weight of steel per set 14 per cent.

The main difficulty to be overcome before making the change was to obtain satisfactory cruciform chuck bushings at a reasonable cost. This was accomplished by purchasing cast-steel bushings which only required to be finished on the outside after receiving at the mine. These bushings cost 35c each in the East and proved in every way satisfactory.

TRYOUT OF HAMMER-STOPING MACHINES.

Early in 1908 the writer made a thorough tryout of the hammer-stoping machines then on the market. A stope was turned over exclusively to these machines in charge on each shift of a reliable, unbiased, first-class miner, exceptionally well qualified, as known through long personal acquaintance, to give a thorough and fair trial. A three months' trial proved conclusively that this type of machine was not adapted for stoping as carried on at Treadwell. These machines are best adapted for more or less vertical holes, and a number of them are always in use in the mines for drilling survey and light plugs and in driving raises where the ground is not too hard. Slate raises are always driven with hammer drills, but when a very hard rib of ground is encountered, the contractors set up a bar and haul up a 3¼-in. piston machine—a hard task when the raise is of any height, though a profitable one as they have found by experience.

Water-Leyner machines were then tried, and they survived the prejudice against introducing anything new and proved their economy over the piston machines.

EFFECT OF INTRODUCING WATER-LEYNER DRILLS

These water-Leyners were strictly one-man machines weighing about 110 lb., and they averaged as much footage per shift in the stopes as the two-man piston drill. The increased cost for hollow steel, drill-sharpening, oil, general repairs and upkeep was far more than offset by the saving in labor. The rate of air consumption for the water-Leyner was about 80 per cent. of the 3¼-in. piston machine, but as the Leyner ran steadier, the daily air consumption might not be much different. By 1913 all stoping piston machines in the Mexican, 700 and Ready Bullion mines had been gradually replaced by water-Leyners, and progress was being made toward replacing the piston machines in the Treadwell mine.

A Treadwell mine crew drove the main crosscut 12 ft. wide, from the central shaft on the 2,100-ft. level by using a crossbar on which were mounted four water-Leyner machines, making a progress in the month of April, 1914, of 372 ft., which was far more than was ever made in any of the mines previously in the same length of time. The crosscut was started with two piston machines run by a machine man and helper. Overnight this equipment was replaced by four Leyner machines, and the machine helpers became, like their partners, machine men. These water-Leyner machines finally overcame the misgivings of the dyed-in-the wool piston-machine men and made a good start toward replacing piston machines in the Treadwell mine.

Shaft sinking had been done with 3⅝-in. piston machines for so long that when it was decided to sink the Ready Bullion shaft with hammer drills, the contractors would not bid on the shaft. It was therefore sunk on a day's-pay. basis at a saving to the company, and proved a demonstration to the contractors, who were willing to take the shaft on contract before sinking had finished. Since the sinking of this shaft, the self-rotating jackhamer machines have been introduced and proved a great improvement.

OLD PRACTICE OF DRILLING LONG ROUNDS DEPRECATED.

The popular slogan adopted generally by up-to-date enterprises of the day—"Safety First"—calls loudly for the change of the old practice of drilling long rounds in the bottom of a shaft. Such necessitate the use of large quantities of powder, produce a great pile of muck, expose the crew to the danger of exploding powder in cleaning it out and later to the danger of drilling into missed holes. The change to the jackhamer machine will answer this call, and the same slogan will hurry along the replacement of piston machines in drifting by the water-Leyner type.

Following is a tabulation of the average footage drilled per machine-shift for a period of seven years by machines engaged in stoping:

Year	Ready Bullion	Mexican	Treadwell
1907	33.3 ft.	31.1 ft.	.....
1908	31.7 ft.	25.9 ft.	33.0 ft.
1909	33.1 ft.	27.2 ft.	26.1 ft.
1910	29.4 ft.	33.5 ft.	26.6 ft.
1911	32.7 ft.	28.6 ft.	27.9 ft.
1912	34.5 ft.	31.0 ft.	26.4 ft.
1913	34.0 ft.	29.4 ft.	28.3 ft.

The Treadwell fiscal year prior to 1911 ended in May. Tabulation for 1911 under Treadwell mine includes 18 months, making the Treadwell mine year conform to the Ready Bullion, Mexican and calendar year thereafter.

The figures under Treadwell mine represent the drilling of 3¼-in. piston machines, the figures for the first four years under Ready Bullion Mine and Mexican Mine represent the drilling of 3¼-in. piston machines, the next two years include piston and water-Leyner machines, while the figures for the year 1913 represent the drilling of water-Leyner machines exclusively.

Although the benefit derived from the change of gage for the piston machines is not reflected in the figures given, it was owing to this change that a falling off did not follow in the drilling as a result of the disturbed condition following labor strikes in 1907 and 1908. The real aim in stoping is not drilling, but tons broken per machine shift. However as the water-Leyner machine in the stope is capable of drilling any hole with equal facility that the piston machine can, and it can moreover drill flat holes which cannot be drilled practically with the piston machine, it follows that the tonnage broken per Leyner machine shift can at least be made equal to the tonnage broken per piston machine shift, and probably will average to exceed it—*Eng. and Min. Journal.*

COMPRESSED AIR PULLS BY PUSHING

Some unusually interesting and ingenious engineering work occurred in the preparation of the sub-foundation of the Lincoln Memorial in Washington, one detail of which warranted the paradoxical title above. This sub-foundation consists of 122 reinforced concrete circular piers from 3 ft. 6 in. to 4 ft. 2 in. in diameter. The shells of these piers were steel cylinders each in three lengths sunk through sand and below that clay and then to a depth of 2 ft. in the solid rock, which was 34 ft. below mean low water level. It was expected that these shells would be operated in the usual way as caissons, the interior excavation being done under pressure, as is so familiar in downtown New York when a skyscraper is to be erected.

It was found, however, that the clay was so watertight that, with some pumping of the inflow, the interior excavation could be done without the air pressure. The excavation of the rock for the final footing of the piers was of course done with pneumatic drills as usual. As the cylinders descended they were subjected to considerable external pressure from the clay which closed around them, so that heavy weights were required to force them down.

It happened that in sinking the cylinders several piles were encountered. Most of these piles came within the cylinders and could be dug out, but one caught the edge of a cylinder and deflected it 3½ ft. from the vertical so that it was necssary to draw it out and start it again. To do this pulling there was not only the entire weight to be lifted but also the pinch of the surrounding clay to be overcome.

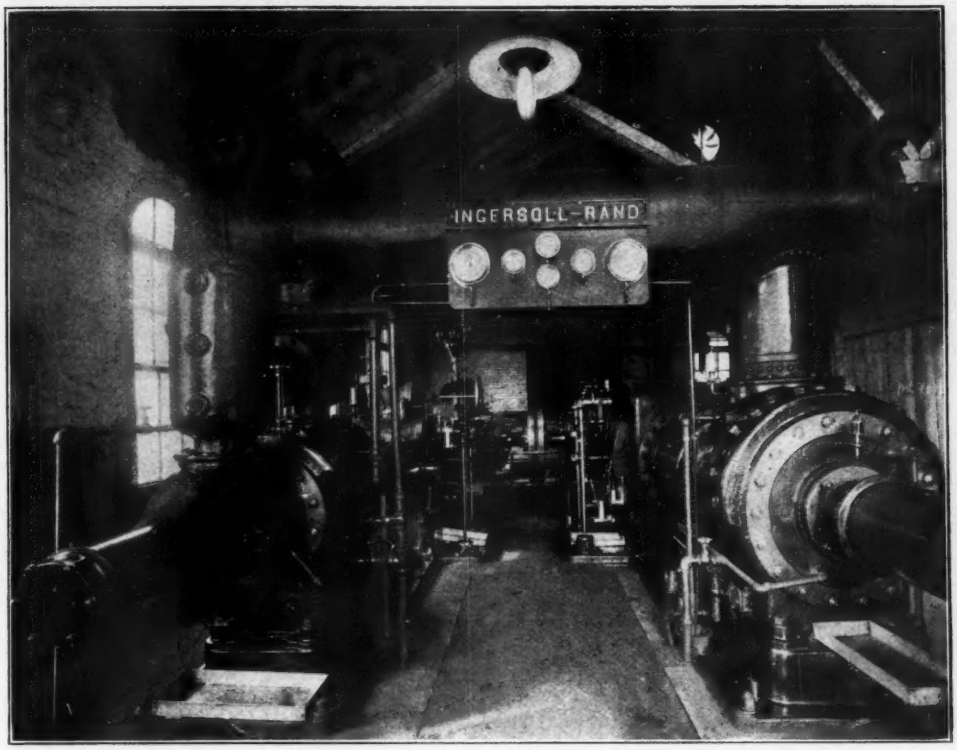
The cylinder was closed with an air tight top bolted to angle irons and a lifting pressure of about 50 tons was applied by derrick and jacks, but this failed to move the cylinder. It was then allowed to fill with water from the bottom and compressed air at a pressure of nearly 100 lb. was admitted to the top of the cylinder. If this air had been admitted slowly its effect would have been chiefly to expel the water, but as it was turned on as suddenly as possible the pressure under the cylinder head, aggregating more than 80 tons, and resisted below it by the inertia of the body of water was effective help for the lifting of the cylinder. The air pressure was thus turned on suddenly twelve successive times, and the cylinder was only raised about an inch. On the next trial, however, the cylinder shot up 15 ft. and was then easily removed and subsequently sunk again in correct vertical position.

GASOLINE LOCOMOTIVES BAD FOR MINE AIR

"Gasoline Mine Locomotives in Relation to Safety and Health," is the title of Bulletin No. 74, U. S. Bureau of Mines, and is authority for the following:

The noxious gases from a gasoline engine used in a mine must be so diluted by the air current as to make them harmless. Air with 0.05 per cent. carbon monoxide is sufficient to produce in time very slight symptoms of poisoning in man; 0.10 per cent. may cause a headache in 40 or 50 min. These facts seem to indicate that the allowable percentage of carbon monoxide should never exceed 0.1 per cent. for short and infrequent intervals, and that the average content should be kept below 0.05 per cent.

To keep the carbon-monoxide content of mine air below 0.10 per cent. would require that 1,000 cu. ft. of fresh air per min. pass the locomotive for each cubic foot of carbon monoxide possible for the locomotive to generate. The greatest proportion of carbon monoxide observed in the exhaust gases during the tests was 13.5 per cent. with the engine running at full speed and full load. The air required can be reduced in the ratio of twice the percentage of carbon monoxide actually found by test, to the maximum percentage of 13.5. Multiplying by 2 the actual percentage found by test provides a factor of safety to cover occasional lapses of operation and interruptions of ventilation. Thus a locomotive having four 7x7-in. cylinders is capable of generating with poor carburation 18 cu. ft. of carbon monoxide per min., and 18,000 cu. ft. of air per min. should pass the locomotive when so operated, to keep the proportion of that gas below 0.1 per cent. If the quantity of carbon monoxide produced during actual operation was shown by test not to exceed 4 per cent., it would seem safe and reasonable to assume that $\frac{8}{13.5} \times 18{,}000$, or 59 per cent of 18,000, or 10,700 cu. ft., would be a safe quantity under the stated conditions.



A MONEY SAVER OF THE KINGSTON COAL COMPANY.

HIGH CLASS EQUIPMENT PAYS WELL EVEN WITH COAL AT 40 CENTS PER TON

BY S. W. SYMONS.

Many coal operators seem to consider that a low fuel cost is sufficient warrant for installing low first-cost mechanical equipment, regardless of the operating economy to be expected.

This is particularly to be noted in the case of the much-abused air compressor. Reliability has been and still is considered a factor of prime importance, and the "old reliable" straight-line simple-engine-driven compressor has been almost invariably chosen.

Of late years, however, operators have come to realize more and more that the high-class duplex compressor, with compound steam cylinder and corliss-valve gear, and two-stage air ends, will give equally if not more reliable service, together with a decree of economy so far ahead of the straight-line machine as to warrant its installation when fuel is even as low as 40c a ton.

An instance of particular interest is that of the Kingston Coal Co., at Kingston, Penn., which some time ago discarded two straight-line-tandem-compound compressors (which had been in use only four years) and replaced them with a single duplex corliss machine with compound steam cylinders and two-stage air cylinders.

This installation is of interest to the coal operator, since it shows in round numbers the saving made possible by the installation of refined, up-to-date equipment.

HOW IT HAPPENED.

Some years ago a consulting engineer—a salesman representing the Ingersoll-Rand Co. —stopped at the No. 4 breaker of the Kingston Coal Co., where there were two tandem-compound Meyer valve compressors, each having a rated capacity of 2,600 cu. ft. of free air per minute. The master mechanic made the statement that they were constantly installing boilers at this particular place, as their compressors were extravagant users of steam. The salesman suggested that instead of buying boil-

ers they should buy an economical air compressor and save the expense of extra boilers and the continuous handling of coal. To drive the argument home indicator cards were taken from the compressors and a statement was made of the saving that could be expected.

THE COMPRESSORS HAD BEEN INSTALLED RECENTLY.

The master mechanic stated that the compressors had been installed only a little over three years and it would not be possible to get his company to throw them out and purchase new ones. For 16 months the salesman continued to pound the Kingston company in an endeavor to secure the installation of a single corliss unit in place of the two straight-line machines, using operating economy as the "big stick," until finally an order was placed for a 30-in.-stroke corliss compressor having compound steam cylinders of 20 and 38 in. diameter and two-stage air cylinders of 20¼ and 33¼ in. diameter. The machine when operating at 120 r.p.m. has a rated capacity of 3,336 cu.ft. to 100-lb. pressure. The order was finally placed and the machine installed and put in operation.

The mechanical engineer of the Kingston Coal Co. relates the incident that he was in the compressor house when the new compressor was turned on to carry the load and the two discarded compressors were shut down, and that after it had been in operation about 30 minutes, the foreman of the boiler house rushed up to the compressor house window and shouted, "What in h— is going on here? Aren't you going to run the compressors today?"

THE RECORDS SHOW RESULTS ATTAINED.

After about two months of operation the following data, taken from the master mechanic's records, were submitted:

"The records show that the company has been able to shut down three 300-hp. B. & H. boilers. In the working day of 24 hr. it was able to save 48 tons of coal per day, which is valued at 40c per ton, making a saving of $19.20 per day on coal. The water meters show that it is saving $1.44 per day on water. It saves $5.28 on labor, making a total of $25.92 per day saved. As this plant operates continuously for 365 days per year, it makes a total net saving of $9,460.80 per year. In addition to this it has been able to dispense with $21,000 worth of boiler plant. It figures that the new compressor, installed on the foundation, cost $13,500.

The compressor was at first operated non-condensing, but later a condensing plant was installed, resulting in a still greater saving.

This company has recently installed a duplicate of this machine, and also an Erie City Lentz engine, which shows that it realizes thoroughly the saving that can be obtained by the installation of economical equipment, even in a region where coal is valued at only 40c a ton.

SEVERE TEST OF THE BRASHER AIR BREAKWATER

A little over a year ago it was questioned in these columns [Scientific American] whether or not Mr. Philip Brasher's invention would turn out to be of practical value when battling with the very exacting circumstances of an exposed seacoast. Prior to that time he had given his "breakwater" trials in more sheltered positions, and while the results were decidedly promising they were not of a nature to answer our query.

As can be recalled, during January just past, the Pacific coast was swept by a severe gale that destroyed much property along the shore and ravaged the sandy beaches to a wide extent. Among the structures exposed to the fury of the winds was a pier 2,100 feet long reaching seaward from El Segundo, California. A year before this wharf had been 4,100 feet long, but substantially half of it was then carried away by the waves during a violent storm. The structure was then so racked that it was not in a condition to witstand an attack of even lessened severity, and yet its maintenance was quite vital to the continuance of certain important shipping operations. It was to protect this pier from further harm that a so-called air breakwater was installed, and happily it was ready for service when the hour of trial came.

Fundamentally, the equipment was decidedly simple and consisted broadly of the following essentials. The seaboard end of the wharf has a width of 70 feet. Parallel with this and 145 feet farther out, 4-inch piping, perforated, was laid on the waterbed for a length of 120 feet. Each end of this was coupled up to smaller pipe leading back to the pier and was fed by two compressors, each having a capacity

4,100 FOOT PIER AT EL SEGUNDO, CAL.

of 1,000 cubic feet of air per minute. On each flank of the dock head was laid under water more perforated piping running parallel with the face of the pier for a distance of 100 feet, thus giving a total length of 320 feet of air breakwater. These flanking sections also drew their air from the two compressors, and they were designed to catch any seas that might get in around either end of the outlying 120 foot section.

When the storm came that was to put the installation to an exacting test the waves had a height varying between 12 and 15 feet, and were, undoubtedly, of ample size either to have wrecked a part of the dock outright or to have racked it harmfully. The pier was a costly structure and the owners might profitably have spent a good round sum to insure its security. During the worst of the storm and as long as the waves were big enough to threaten harm, the two compressors were kept going. This was for a period of 23 hours, and as the air bubbles rose surfaceward from the perforated piping they served to blast the billows, or, to be more exact, destroy the wave motion of their masses. As a result, the rollers seemed to drop as if their foundations had been knocked out from under them, and the remaining motion lacked sufficient surging force to disturb the supporting piles among

SMOOTH WHITE AREA CAUSED BY AIR DISCHARGE.

which they eddied as they spent themselves in their shoreward travel.

The compressors were located something like 2 miles away from the breakwater, and, allowing for leakage en route, it is probable that not more than 1,500 cubic feet of air was available for service at the perforated pipe. Under normal conditions, the air pressure need not be but a trifle in excess of the hydrostatic head, in this case the pipes were laid in 30 feet of water, but it so happened that the compressors at El Segundo were for much higher pressures and, therefore, more expensive to run. This added needlessly to the outlay, and yet for the 23 hours of continuous service the cost amounted to only about $60. Surely this was a very modest price indeed to pay for the saving of that pier.—*Scientific American.*

PNEUMATIC CONCRETE MIXING, CONVEYING AND PLACING*

BY A. E. COMSTOCK.

On Section 5 of the Broadway-Fourth Ave. subway, which includes the two-track structure on 59th and 60th St. from Seventh Ave. east to Second Ave., the concrete lining of the tunnels and other structural concrete are both being placed by compressed air.

The machine used for this purpose is designed for both mixing and placing concrete. It consists of a drum about 4 ft. in diameter by 2 ft. deep, on the under side of which is attached an inverted cone-shaped section extending about 3 ft. below the bottom of the drum and terminating in a 6-in. discharge pipe. On top of the drum is a feeding hopper, and inside is a horizontal door, sliding in cams so adjusted that, in closing, it is brought tightly against a gasket on the top of the drum, thus making an air-tight lock. The door is operated by a hand lever connected to it by a piston rod passing through the drum.

The cone-shaped section underneath the drum is fitted near its top and bottom with about 12 small inlet pipes, through which air is forced for the purpose of agitating the materials until they are thoroughly mixed before the mixture is driven through the discharge pipe to the forms. The discharge pipe is attached to the cone by a T-connection, from the free end of which a 2-in. pipe leads to the compressed-air reservoir, and another 2-in. air connection is located at the top of the drum.

When the process of mixing has ben completed, the air is turned on at both connections, the air through the upper one forcing the concrete down into the discharge pipe, while the air through the lower one forces the concrete forward to the forms.

When the machine was first put into operation on this contract, the agitators were not used, as it was thought that the materials would become sufficiently mixed in transit through the discharge pipe and upon being deposited in the forms. Repeated trials made by this method proved unsuccessful. The aggregates failed to mix properly with the cement and water and were deposited in the forms in a condition varying from very wet to dry. Being deposited under an initial pressure close to 100 lb., the materials that had become only slightly wet were compacted to such an extent that rehandling was difficult and involved considerable loss of time. Furthermore, an appreciable amount of sand and cement that had not come in contact with the water was blown clear of the forms. Later developments showed that dry materials had a tendency to clog the pipe more frequently than those thoroughtly mixed with water.

Various methods and contrivances were used to overcome these difficulties and obtain a better mix, but without satisfactory results. An attempt was then made to use the agitators, but these were found to have become obstructed with cement to such an extent that it would have required a considerable loss of time to clear them. Moreover, it was the opinion of the engineers that the agitators would fail to do the work for which they were designed; for when the materials are placed in the mixer, they drop first into the discharge pipe and fill upward from that point, and all materials below the lower set of agitators would not be affected by them. Also, the agitators would act simply as an air inlet and would immediately cause the discharge of the materials from the machine before mixing could take place.

*Portion prepared by Mr. Comstock of a paper by Robert Ridgway, Engineer of Subway Construction, Public Service Commission, New York City. Read before the American Concrete Institute, Chicago, Feb. 14, 1916.

An arrangement was then made by which the materials could be thoroughly mixed to the proper consistency before being placed in the air mixer. This method, with proper spading and sufficient rehandling in the forms when necessary to insure an even distribution of materials, has resulted satisfactorily and is the method now being used. The arrangement of the plant at the mixing point was such that with a slight modification this method of mixing could be used continuously.

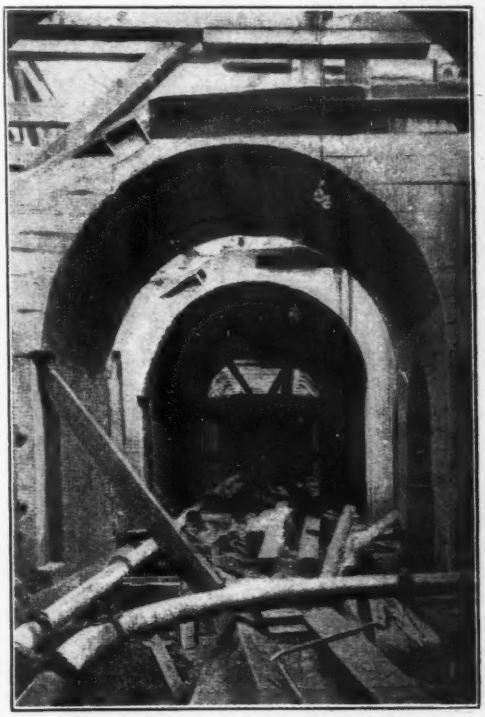
Two storage bins, one for sand and one for gravel, each with a capacity of about 12 cu. yd., are erected with their tops at the level of the street, in such a position that trucks discharge into them conveniently. At the bottom of each bin is a gate through which the materials are run into a hopper gaged for measuring the sand and gravel. At this point there is a platform, covered and water-proofed, where the cement is handled and temporarily stored, on which is located a water tank fitted with an improvised measuring gage and connected to a steam boiler for the purpose of heating in cold weather. The steam pipes also pass through the storage bins for the same purpose. At the bottom of the measuring hopper is one gate which, when opened, allows the sand and gravel, to which the cement has been added, to run together into the mixer.

Before experimenting with the air mixer, a rotating mixer had been in use in placing the track floor and wall benches. Space was provided in the arrangement of the plant to set aside one mixer in case it was desired to use another. Upon the failure of the air machine to mix properly, it was replaced by the rotating machine, lowered to a position above the air machine and so arranged that the rotating machine could thoroughly mix the materials and discharge into the latter with the previously mentioned satisfactory results.

ESSENTIAL DETAILS IN USING AIR FOR THE CONVEYING

The discharge pipe should be laid in the most direct line between the mixing point and the forms, avoiding bends as mush as possible, since all bends retard the passage of concrete through the pipe, encourage congestion and increase the time of transit as well as the consumption of compressed air. Where bends are necessary, they should be sweeps of large radii, about 15 or 20 ft. Short bends of 4 or 5 ft. were used on this contract in the early experiments with this method and were found to clog more frequently than those of larger radii and to wear through in a few hours, with consequent loss of time for repairs.

When the pipe becomes clogged, sounding at the point of congestion will usually loosen the the obstruction; but it is sometimes necessary to remove the obstructed part and clear it by other means. At every point where the pipe changes direction there is a decided shock when the concrete strikes the bend. It is therefore necessary to have such points securely braced,



CONCRETE CONVEYING PIPES IN SUBWAY.

in order to prevent unnecessary strain on the joints, particularly at the outlet, where the shock would otherwise cause a shaking and consequent loosening and displacement of the forms, if there is any contact between the pipe and the forms— a condition that cannot always be avoided. The original position of the outlet of the discharge pipe should be located centrally in the forms, since each change of pipe means additional loss of time for bracing.

In passing through the discharge pipe, especially over long distances, the concrete has a tendency to spread out along the bottom

rather than move in a solid mass through the full section of the pipe. If this condition continued to the outlet of the pipe, much of the air would pass over the materials, resulting in a loss of pressure, a longer time in discharging and a separation of materials at the outlet. In order to avoid this it is necessary to have a rise, vertical or nearly so, at or near the point of discharge, so as to cause the concrete to fill the pipe completely and to discharge more uniformly.

In order to obtain the proper distribution of concrete in the forms with as little rehandling as possible, a flexible rubber pipe was attached at the outlet, with the idea of directing the flow to different points, as desired. This proved practically useless, as the pipe buckled, was difficult to control and was soon worn out. It was therefore replaced by a T-connection that could be turned to any desired angle in a vertical plane and satisfactorily provided the required distribution.

This method of placing concrete is particularly adapted to filling tunnel arches, the discharge pipe being laid along the crown of the arch to about the middle point of length of the section and the T turned alternately on each side until the arch is filled to the level of the crown. The T is then removed and replaced by a piece of straight pipe extending to within a few feet of the far end of the form, the whole length of the pipe inside the form is raised to a position tight against the rock along the highest available line, and concrete is pumped in until the arch is filled up to the outlet of the pipe. The pipe is then removed and replaced by a shorter piece extending about 6 in. into the form at the most advantageous high point; the bulkhead is sealed and the blowing of concrete resumed until the arch is filled to the point of refusal. The pipe is left in place until the concrete has set long enough to be firm, when it is removed and cleared of any concrete remaining in it. It is impossible to seal completely all voids in the roof of a tunnel by this method of placing concrete, unless the rock breaks fairly smooth without leaving pockets above the general surface.

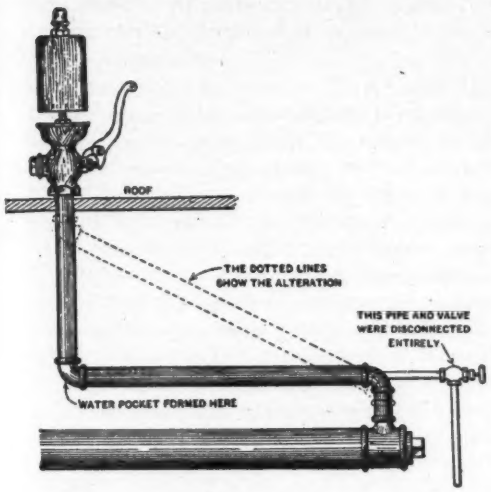
Care must be taken to avoid overtaxing the forms, as the high pressure of air added to the weight of the concrete is likly to displace or rupture them, and such an accident actually occurred at one point on this work. On this contract the point of deposit farthest from the mixer is about 500 ft.,and the time required to discharge a two-bag batch of concrete over this distance varies from 30 to 40 sec. Each batch is mixed for about 1 min., during part of which time the previous batch is discharged into forms. Under favorable conditions about 1½ min. are required to mix and place each batch; but on account of time lost in spading the mix in the forms, occasionally changing the position of the pipe, clearing obstructions and waiting for the proper amount of initial air pressure, a fair average between batches may be assumed as about 3 min. The time required decreases in length as the point of deposit approaches nearer to the mixer. It therefore requires about 12 hr. to line a section of tunnel roof 25 ft. long, which contains 80 cu. yd. of concrete, including excess.

At the present time there are two single tunnels each about 300 ft. in length, being constructed by this process. Part of this double tunnel is open-cut construction, where complete tunnel sections above the track floor, each 10 ft. long are being poured at one time as monoliths. The work is in progress at three points, thus keeping the machine in practically constant use. Steel forms and carriers are being used for tunnel sidewalls and timber arch forms on steel carriers for the tunnel roof.

USE OF COMPRESSED AIR FOR FIRE WHISTLES

The illustration herewith, which comes from The Wm. Powell Co., Cincinnati, tells the story of a not unfamiliar experience when steam is used for a fire whistle.

"Some years ago," says the writer, "our town voted to put in an electric fire alarm, and as a large part of the firemen were "call" men it was thought advisable to have a steam whistle attached to the circuit, so that all the firemen might be notified of the fire when at their usual vocations. From the first there was trouble in not being able to count the blows on the whistle, so one day the chief engineer of the fire department asked me to take a look at the whistle and see if I could find out what ailed it. He said that the first blow and sometimes the second was so full of water that no sound came. Now I immediately disclaimed



TROUBLE WITH STEAM WHISTLE.

any knowledge of fire whistles but met with the remark, "Well, you will look at it, won't you?" This I consented to do. I knew that it must be piped up right; the man who piped up the plant knew his business thoroughly, for I heard him say so, and so I reasoned that the fault could not lie with any of his work. But in thinking the matter over I decided in my mind where the fault was, and so took my spirit level with me when I went to examine the apparatus. The accompanying sketch shows the then existing state of affairs.

"Upon putting my level upon the whistle pipe I found that at the end of the pipe where it went up through the roof it pitched about two inches, making a pocket that was always full of water. Then there was a half-inch pipe leading to a receiver in the basement, but as the cut shows this was on the wrong end of the whistle pipe to be of any benefit, and when the whistle was blown, water was forced up from the receiver as well as from the pocket, and the total water must have been half a barrel, making a fine fountain but a poor whistle. Now, as to the remedy. My recommendation, which was adopted, was in the first place to disconnect the one-half inch pipe from the receiver, for as it is now used it would be unnecessary; and in the place of elbows put in forty-fives, so that any condensation would return to steam pipe as fast as it was made. Also to cover all piping thoroughly. Now the first blow is as clear as any, and there is no trouble. I am inspired to write of this experience because this same trouble has been reported to me as occurring in a neighboring town lately, and there may be others whom this may benefit."

The use of steam for a fire whistle calls for a constantly and instantly ready supply of steam especially at night and on Sundays, and we all know what such a requirement must mean, even when pipes and valves are all right. A good air receiver and a small electric driven or gasoline driven compressor would eliminate all trouble.

AIR LIFT SUGGESTIONS

BY JOHN D. KILPATRICK.*

For any number of wells, scattered as they usually must be over quite an area, the air-lift system has proven itself to be the most available method for delivering a large supply of water on the surface of the ground. It is not advisable, however, to use the air-lift (except under extraordinary conditions) for delivering the water higher than to the level of the ground. At best the air-lift is an expensive way of pumping, but where the water is obtained in large volume below suction limits, it would seem to be the only possible method. The air-lift system has the great advantage of not having any moving parts in the well, and there is absolutely nothing to get out of order in the air-lift itself. The moving parts of the system are all in the air compressor in the engine room, under the eye of the engineer. The engine room may be located at the most convenient point, and the farthest well may be a mile or more away from the air compressor.

If the air lines are correctly designed and properly laid, there need be but little loss of pressure. The main fault that the speaker has found with a great many air-lifts throughout the country has been in the air-lift piping in the wells. It is a familiar fact that a prime consideration for an economical air-lift is that there should be 60 per cent. submergence. For instance, in a 100-foot well, there should be at least 60 feet of water when the well is delivering its yield; but the principal trouble is found in the design of the air and water piping, so that the compressed air is delivered at the bottom of the uptake water pipe with as

*American Water Works Association.

little loss by friction as possible, and that the uptake water pipe is designed so as to deliver the water, without being so large as to have an extreme amount of slip, or so small as to develop excessive friction.

Evidence of faulty design is shown by the discharge being in alternate pistons of water and air. In a properly designed air-lift system, the water should be discharged in a practically uniform stream, with very little surging. A great many foot pieces have been designed which have for their object the spraying of the air at the bottom of the uptake water pipe so as to introduce the air into the water in streams of very fine bubbles. It was discovered early in the development of the air-lift that the finer the spray could be made, other things being equal, the more efficient the air lift became; but no foot piece that was ever designed can work efficiently if the air pipe leading down to it and the up-take water pipe from it are not of such sizes as are suitable for the particular problem involved in that well. The great object to be accomplished by any foot piece is to offer as free and clear a water passage as is possible, so that there will be no eddies formed in the water column which cut down the velocity and impair the efficiency. Above the foot piece the mixture of air and water should have a pipe with as smooth surfaces as it is possible to obtain.

METHODS OF PIPING.

The three methods of piping wells may be termed: (1) The outside air pipe; (2) the inside air pipe; (3) the annular system. In the first case the air passes down outside the water pipe and into some type of foot piece or openings at the bottom with the water passing up through the inside of the water pipe. In the inferior pipe system the air passes down the inside air pipe to a foot piece or nozzle, and the mixture of air and water is blown upward between the outside of the air pipe and the inside of the water pipe. In the annular pipe system, one pipe is within the other, the space between the two pipes being the downtake air column, and the interior of the inside pipe being the uptake water discharge pipe. It is impossible, without an exact knowledge of the conditions, to determine which of these three systems it is best to use, assuming that the proper areas are available in each case for the amount of air necessary and the amount of water required to be lifted.

There are cases where the diameter of the well is so small and the amount of water to be delivered so large that there would not be room in the well for the outside air pipe in addition to the uptake water pipe. In this case, it might be better to use the well casing as the downtake air pipe and only provide an uptake water pipe. This arrangement, however, is sometimes impossible on account of air leakage through the joints of the well casing, which were opened up when the well pipe was driven. It is very hard to generalize and lay down rules for piping up wells on account of the different yields, depths and submergence of wells, and this is sometimes still further complicated by the number of wells that have to be pumped.

With a great number of wells to be pumped from the same air compressor, very delicate adjustments are required, so that all the wells may be started at the same time. The speaker believes that it is preferable to use a single air line, with outlets to each of the wells, rather than separate air lines from the pump house to each of the wells, both as a matter of economy of installation and economy in the use of air. The plea sometimes made that independent air lines to each well allow of adjustment within the engine room is invalid because the place to adjust the well is at the well itself, and if the plant is properly designed originally it should not be necessary to adjust the wells except at considerable intervals of time, and then only because of the increased requirements made on the plant, or fluctuations in the wells themselves.

BENEFIT OF HIGH PRESSURE GAS FEEDING

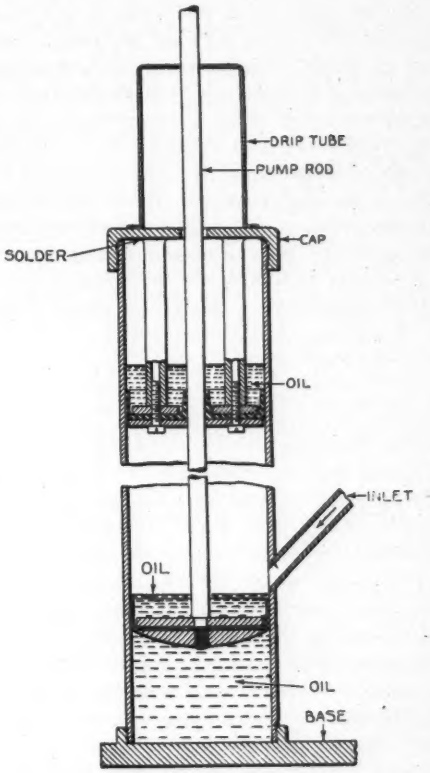
Seeing that compression of gas condenses out much water vapour, naphthalene, etc., from gas, W. H. Bennett, gas engineer of the Redhill Gas Co., suggested in a letter printed in "Gas," of London, last December, that it would be wise to deliver a certain amount of high pressure gas through governors into the low pressure system as a means of alleviating naphthalene troubles. He remarked that while lately he had had, like many engineers, much trouble from a recrudescence of such stoppages, his district was quite immune in the

parts supplied from high pressure mains. A striking confirmation of the value of this suggestion comes from Bergen. In the severe Norwegian winter the freezing of condensed moisture, especially if naphthalene crystals are also embedded in the mass, is a very great source of trouble to gas engineers. Engineer Schieldrop finds that though his low pressure mains are subject to this trouble, he gets no such deposits in the districts fed from high pressure mains; consequently he now uses as great a proportion of high pressure gas as possible in his low pressure mains, and is fully justified, he says, by the results.—*Gas Record.*

A SIMPLE VACUUM PUMP

BY CHARLES E. DURYEA.

Often a good vacuum is required and no ready means at hand to produce it. In these days of cheap pumps for auto tires a good vacuum pump can be easily made. Select a pump with a screw cap and a long barrel which may be unscrewed from the base. Close the outlet in the base and solder an inlet tube in one side of the barrel about two inches above the bottom. This inlet tube should extend outward and upward at about 45 degrees so that any oil which may enter it will return to the barrel. The leather cup on the pump rod should be turned over so as to act on the pull stroke. Fit a similar cup two or three inches below the top, which may be supported from the top cap by two or more short rods soldered to the top and the metal parts which hold the cup. The cup leather for this cup should be stretched up in its center so as to form a packing around the pump rod. If a cup already with a hole through it is used a second layer of leather may be added to make this rod packing. On the top of the cap solder a tube about two inches long to catch any oil the pump rod may carry out with it. The pump rod fits loosely in the hole through the top so the air can get out alongside of it freely and any oil can run back easily. Screw the bottom on the barrel, pour some oil into it and insert the parts. Depress the piston cup as far as it will go. The oil should more than fill it. Raise it as far as it will go and the excess comes into the top cup, and partly above. There must be no hollows on the underside of either cup to hold an air bubble. If a little more certainty is desired at this point conical



HOME-MADE AIR PUMP.

nuts can be used to grip the cups and they may extend to the barrel walls.

The down stroke now starts with no air between the cups and an oil seal to both cups. Little imperfections of the cups do not matter if the oil is fairly heavy, as for example gas engine cylinder (auto) oil. The space between the cups fills with air from below which meets some resistance forcing its way past the cup and oil until the cup passes below the inlet tube, when this resistance is away and the barrel has a vacuum equal to the vessel being exhausted. The piston cup sinks into the oil below, filling itself again to normal level, and begins to carry the air above it as soon as it passes the inlet opening. At the top it empties completely, forcing such oil as has leaked in from the top cup, up into it again.

Most air pumps fail when there is no longer enough air remaining to lift the valve, and a very light valve takes a surprising amount of air to lift it. This pump has a perfect vacuum between the cups when this non-raising condition is reached, and as soon as the piston cup

passes below the inlet this vacuum fills from the exhausted space with no resistance whatever. Possible air bubbles and a slight oil vapor seem to be the only dangers. If the last strokes are made slowly and with some interval between, the bubbles will float to the top and pass into the cup above with the excess oil. If oil vapor is feared boil the oil till all low test vapor passes off. The space above the top cup should be long enough to hold the oil in it without spilling when the pump lies flat. The oil-catching tube may have a flange inside its top end for the same purpose.—*Scientific American Supplement.*

CARELESSNESS KILLS

From a Coal Age collection of narratives of accidents caused by carelessness we select the following which, after the event, seems scarcely credible:

At a certain mine the slope hoisting engineer is required to look after two large air compressors, which are in the engine room, in addition to his duties as hoisting engineer. The slope is approximately 600 ft. long and is used exclusively for hoisting and lowering men. A covered cage is used and of such a type that it is impossible for more than one man to get in or out at the same time. The distance from the mouth of the slope to the engine house is about 100 ft. While the engineer was engaged in hoisting a cageload of men, something went wrong with one of the air compressors, requiring his immediate attention. Instead of stopping the cage and then looking after his other work, he left the engine while it was running and went to the compressor. He probably thought it would take but a moment to fix the compressor, and as the hoisting engine was running slowly, he would have plenty of time to spare. Perhaps he had done the same thing before. However, the air compressor required more attention than he anticipated. The shouts of the men as the cage was dragged through the space between the mouth of the slope and the engine house called his attention to the throttle. Before the engine was stopped, however, the cage crashed through the side of the building and over the hoisting drum, resulting in the death of one man, the father of a large family, and several other men were injured.

DELAY CARTRIDGES

A safety feature for those engaged in blasting is the use of what are called "delay" cartridges, which enable a blaster to count all the holes in a round and make sure that all have gone off. In the first hole an ordinary blasting cap is put. The second hole is fired by a delay blasting cap, the third hole by a second-delay blasting cap, the fourth hole by a third delay blasting cap, and so on. All the caps are on the same circuit, and all are ignited by one operation of the blasting machine. The delay caps fire the charges in order, and with a sufficient interval between explosions to permit of counting the shots, so that the men doing the blasting can tell absolutely that every charge has gone off before they return to the cut.

POWER-PLANT LOSSES AT HIGH ALTITUDES

BY A. VINCENT CLARKE

The pressure of the atmosphere at sea level is 14.7 lb. per sq. in. At lower depths it is increased, and at higher elevations it is less. This reduction of the atmospheric pressure at high altitudes must be taken into account before power plants are installed in such places.

With steam plants the boilers cannot generate as much steam as it is possible to do at sea level, for owing to the rarity of the atmosphere the same volume of air contains a smaller weight of oxygen, and for the same velocity of air through the grates and flues a much slower rate of combustion is obtained.

Considering the engine alone, the working at the high elevation is beneficial because, owing to the reduction of the back pressure, the same quantity of steam at the same pressure as at sea level will develop greater power than can be obtained at sea level. [It must be remembered that absolute pressure, and not gage pressure, is here spoken of. Ed. C. A. M.] With noncondensing engines this is most apparent, for at an altitude of 10,000 ft. above sea level the reduction in the back pressure is equivalent to the addition of nearly three pounds to the mean effective pressure on the low-pressure piston.

To obtain the same evaporation from a boiler at a high altitude as can be obtained at sea-level, it is necessary to use forced draft, but the employment of this might increase the velocity of the air and gases through the grate

and flues to such an extent that the operation of the boiler would become uneconomical and it would be better to have a larger one.

Oil engines working at high altitudes cannot develop the same power as at sea level, owing to the smaller weight of oxygen contained in the cylinder. The amount of fuel oil that can be consumed, assuming perfect combustion, is in proportion to the quantity of oxygen present in the cylinder, and because the piston displacement is unalterable, the weight of oxygen in both cases will be in a ratio to the densities of the atmosphere.

The atmospheric pressure at various altitudes is given in the chart, Fig. 1. At an elevation of 10,000 ft. the pressure of the atmosphere is about 10.3 lb. per sq. in. Thus at this altitude the engine cylinder will, at the commencement of compression, be full of air at a pressure of 10.3 lb., whereas at sea level the same volume of air would be present at a pressure of 14.7 lb. The amount of oxygen would be in the same proportion in both cases, so that the power obtainable would be in the ratio of 14.7 to 10.3, giving a loss of about 29 per cent. at the high altitude.

With internal-combustion engine plants intended for working high above the sea level, the lower pressure of the atmosphere will also affect the working of the engine by reducing the compression pressure unless provision has been made for overcoming this. The absolute pressure obtained at the end of the compression stroke, if there is no leakage past the valves and piston, is equal to

$$p_1 \times \left(\frac{V}{v}\right)^{1.35}$$

where

p_1=Absolute pressure at the commencement of the stroke;

V=Total volume—that is, the piston displacement+clearance;

v=Clearance volume.

From this it is seen that if the initial pressure is reduced, then the compression pressure will be lower, and as the satisfactory running of the engine depends upon the maintenance of approximately the compression for which it was designed, it follows that either p_1 must be increased by artificial means or the ratio $\frac{V}{v}$ must be increased. In practice the latter method is adopted and is effected by either lengthening the connecting-rod or making a new combustion chamber having a smaller capacity; thus the compression pressure becomes the same as that obtained at sea level, but the volume of air is less, consequently the same amount of fuel cannot be consumed and the power is reduced.

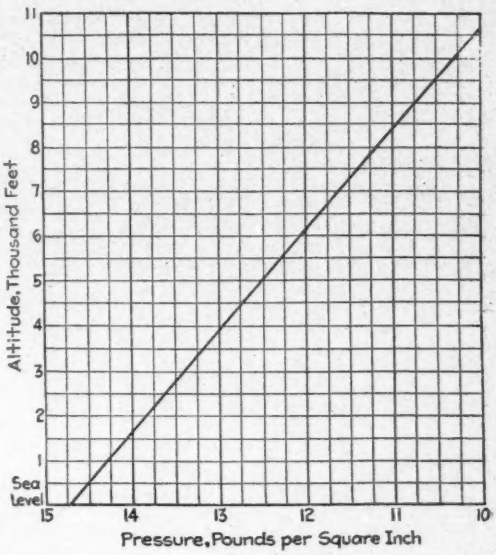


FIG. 1.

Were it practicable to increase the initial pressure in the cylinder to that obtained at sea level, there would be no loss of power at the high altitudes; this result, however, could be obtained only at the expense of the simplicity of the plant, and in addition to the cost of the extra gear, there would be a certain amount of power required for operating it.

For suction-gas plants a larger producer than is required at sea level would be necessary, and it would be problematical whether it did not become a pressure producer after the apparatus for producing the draft and the pressure regulator had been added.

The fuel consumption at high altitudes will be approximately the same as would be obtained when working at the same power at sea level; thus the amount of fuel used by an engine at an elevation of 10,000 ft. when working at its full load will be about the same as would be consumed at two-thirds of its full load rating at sea level.

Diesel engines require a larger compressor for the air used for the injection of fuel when

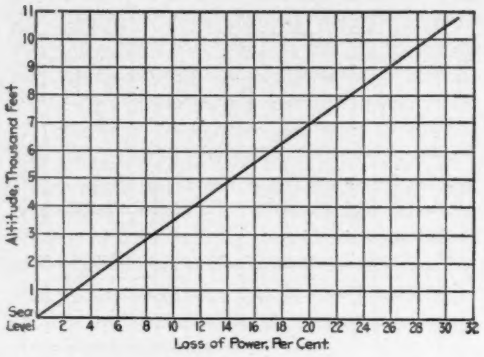
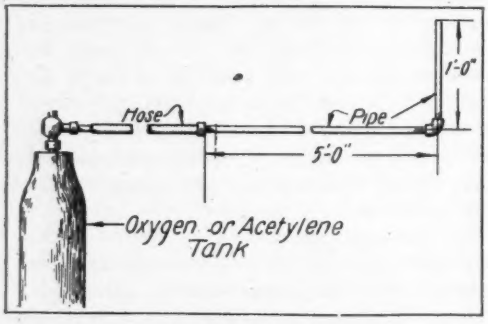


FIG. 2.

working at a high altitude than is necessary at sea level, as it is essential for their satisfactory operation to have the same volume and pressure of air as at sea level.

The loss of power that occurs with internal-combustion engines at various altitudes is shown in Fig. 2, and as the atmospheric pressure can practically be represented by the straight line shown in Fig. 1, it is apparent that the loss of power can also be represented by a straight line.



FOR THAWING TAP HOLES.

THAWING FROZEN STEEL

Everything which melts by being heated will also freeze agin when the process is reversed, although by thoughtless habit we are apt to regard the phenomenon as belonging to water alone. The range of freezing temperatures is practically the same as that of melting temperatures. Liquid air, which looks so much like water, freezes and forms air ice at a temperature about 375 degrees lower. Alcohol freezes at—203 deg. Fahr., Carbonic acid at—108 deg., mercury at—39 deg. Towards the other end of the list iron freezes at about 2,000 deg., and the formation of cast iron ice on the surface of the metal in the ladle is a familiar sight in the foundry.

The freezing of steel occurs at a temperature higher than that of cast iron, and when it occurs in the tap holes of melting furnaces ingenuity has been taxed to devise means to thaw it out again. Mr. T. W. Dagnall writes about this in a recent issue of Foundry. Among the many annoyances of steel foundry operations, he says, are frozen nozzles or frozen tap holes. These are quite frequent occurrences and they are exceedingly costly. In the accompanying illustration is shown a device for thawing out frozen nozzles and tap holes, which has proven quite successful. A piece of ½-inch pipe, about 5 feet long, is coupled to an elbow to which a piece of pipe 12 inches long is attached, thus forming an L-shaped section. To one end of the 5-foot pipe is attached a hose which connects with an oxygen gas tank. The section of 12-inch pipe then is inserted in the nozzle, the gas is turned on and in less than 60 seconds the nozzle is freed from obstruction and the heat can be poured without further trouble. This same contrivance can be used for thawing-out the tap hole of the melting furnace, with the exception that it will be more convenient to employ a straight piece of pipe for this work. When it is considered that a great many heats in steel foundries are lost through frozen nozzles and tap holes, it would seem to be advisable to have a device of this kind as a part of the shop equipment.

COST OF CEMENT GUN WORK*

The upstream face of the Elephant Butte dam of the United States Reclamation Service is being waterproofed with portland-cement mortar mixed in the proportion of one part cement to two parts sand and applied with a cement gun in a coating about 1 in. thick. Advantage has been taken of rising water in the reservoir to work from rafts specially constructed for the purpose. There are two of these, each 9x13 ft., made of planking on a framework laid on and attached to 16 oil barrels. One raft contains the machine, operator and helpers, small mixing box and a few sacks of cement and sand, while the other is loaded with cement and sand.

The coating is applied in horizontal strips

*Reclamation Record.

about 10 ft. high and the length of the dam at water level. The surface is first cleaned thoroughly with scrapers and wire brushes and is then gone over with a sand-blast, using coarse sand, passed through the machine to obtain the necessary pressure. This roughens the surface sufficiently to cause the mortar to adhere to it. The surface is then thoroughly moistened with a hose and the mortar immediately applied. The mortar is put on in four layers, each about ¼ in. in thickness. It was found that a thicker coat than this applied on a vertical wall, without reinforcement, would, on account of its weight, slough off before setting. Each layer follows the preceding one before it has attained its final set, and so far there is no indication of a parting of the layers. Numerous samples taken from the face showed perfect adhesion to the concrete, it being impossible in every case to break the mortar from the concrete at the line of contact. The cost per square foot for the first 100,000 sq. ft. of this coating is as follows:

Operating and repair work, including cost of air and water	$0.015
Staging, cleaning wall, moving, etc.	.006
Cement	.024
Sand, including labor, screening and hauling (sand only 20c per cu. yd.)	.007
Depreciation of gun and equipment	.020
Subtotal	$0.072
Overhead	.007
Total cost per square foot	$0.079

Some experiments were also conducted at Elephant Butte to determine the feasibility and probable cost of troweling the mortar placed by cement gun, with the idea of using the machine for the lining of canals or for repairing lining that had disintegrated and required a smooth finish. The area treated was 75 sq. ft. This was covered with mortar averaging ¾ in. in thickness in 15 min. working time, or at the rate of 300 sq. ft. per hr. for this average thickness. One good finisher troweled 56 sq. ft. in 25 min., or at the rate of 135 sq. ft. per hr. Possibly two men could keep up with the gun. The finishing was not done to a screeded surface. The surface is wavy, but much smoother than a formed surface would be. It could be screeded to a plane, if thought necessary. Care must be taken that too much material is not deposited in one coat, or horizontal cracks will occur, due to settlement. Some cracks appeared in this experiment, and in each one the material was found to be from 1 in. to 1½ in. thick. The cost of this particular experiment, not counting cost of setting up, equipment, etc., was as follows:

Labor	$0.30
Sand, approximately 9 cu. ft.	.90
Cement, 4 sacks	2.00
Total for 75 sq. ft.	$3.20
Per square foot	$0.04¼

Depreciation, staging, moving, etc., would depend on the job, but it is probable that the total cost of placing this coating, including the troweling, under average conditions would not exceed 5c per sq. ft.

In using the cement gun the sand must be clean, sharp and not too fine. It must not be bone-dry, or trouble with feeding will occur. The air pressure should be about 30 lb. in the gun and the water pressure over 60 lb. It has been figured at Elephant Butte that 30 ft. of free air at 100 lb. pressure at the point of delivery to the gun and 10 gal. of water are required per minute.

POWER DISTRIBUTION IN VERTICAL BLOWING ENGINES

Mr. S. P. Baird in Practical Engineer, April 1, calls attention to the distribution of power and work in each blowing stroke of a vertical steam driven blowing engine. The blower cylinder as described seems to be single acting, and if the steam cylinder were also single acting—which of course it is not—the description given of the phenomena occurring might apply, but what would happen during the return stroke? To satisfy the description we have to assume that there were duplex cylinders, both steam and air, with cranks opposite so that the pistons on one side would descend while those on the other side ascended, and for each blowing stroke each steam cylinder would contribute half the power. Similar fluctuations of the balance of steam pressure and air resistance in straight line horizontal machines have long ago been noted.

We have laid down in some of our books, he says, that steam compression should be carried to a point as near boiler pressure as pos-

sible. I was always a great believer in compression as a money saver, and as an aid to smooth running; but I came across one type of engine in which it was impractical to have any compression or, in fact, any lead. To secure smooth running, the diagram should show no compression and a negative lead on the bottom end.

The engines in question were upright blowing engines used to blow Bessemer converters. They were 36 by 48 in. with Corliss hand-regulated releasing valve gear. The blowing cylinders were in line with the steam cylinders and the 2 pistons were directly connected. The air was admitted and discharged from the air cylinder by valves similar to pump valves and normally closed by light spring pressure. There was considerable clearance in the air cylinder, as much as 10 per cent., and the pressure on the blast pipe was 28-lb. gage. The pressure in the air cylinder would continue to rise until it reached the pressure in the blast main—28 lb.; this occurred when the piston had reached approximately ¾ of the stroke, and this pressure continued until the piston reached the end and started on the return stroke.

Now, the idea of compression from a smooth running standpoint is for the purpose of overcoming the inertia or power stored in the rapidly moving reciprocating parts of the engine; but with a tandem compressor, there is already a force acting to stop these reciprocating parts so there is then no necessity for compression on that score. From the economy standpoint the idea is all right, but practically it won't work; because the pressure in the steam cylinder is rapidly diminishing at the time when the pressure in the air cylinder is at its highest, and the difference between the power consumed and the power generated must be made up by the fly-wheels. To have a compression pressure built up at the end of the stroke would stop the engine on the center, and for the same reason there can be no lead.

There is another peculiarity of this type of engine. It is a well-known fact that the guides of ordinary engines are worn most in the center; but with an upright tandem compressor the wear is mostly at the ends, or rather near the ends. The steam pressure being high during the early part of the stroke, with a low air pressure, the surplus energy is stored in the flywheels. This pushing on the connecting rods puts considerable strain or pressure on the guides. At about ½ stroke, the energy consumed equals the energy generated and the flywheels are just floating, neither absorbing nor giving off power; but a little farther in the stroke, the energy generated is growing less while the energy required is increasing and this difference must be made up by the flywheels, thus causing extra pressure on the guides at about ¾ of the stroke due to the push of the connecting rods by the flywheels driving the load. With the next half of the cycle the same things take place, only the pressure on the guide is in the opposite direction and consequently on the other guide. The net result is practically no wear on the center or the ends of the guides; but between the center and the ends, there is a zone of wear on both sides of the center of both guides and of about the same amount.

BIGGER THAN THE RAILROADS

To the average citizen, a great railroad system represents one of the largest aggregations of capital and resource, but a railroad is really one of the small potatoes in comparison with certain commercial establishments. Take, for instance, the Willys-Overland Company, controlling an automobile plant, two tire factories and one starting and lighting plant. This aggregation of energy and capital was not in existence ten years ago, but it expects during 1916 to do a business of $250,000,000. One of the big packing companies, during 1915, handled a business of $500,000,000. In contradistinction, the Southern Pacific Company, operating over 12,000 miles of railway and several steamship lines, with property approximating $909,000,000, and with possibly 40,000 employees, is fortunate if it can earn a gross return of one-half of that of the automobile concern. The manufacturing plants pursue the even tenor of their way and pile up their remarkable net earnings with a proper protection of their resources and revenue; but poor Mr. Railroad is hammered from early to late; shot at, turned inside out, sat on and otherwise made to mark time by the public.—*Southern Pacific Bulletin.*

A soap bubble blown at the Royal Institution, London, by Sir James Dewar on February 17th burst on March 24th, after an existence of five weeks.

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EVERYTHING PNEUMATIC

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PROGRESS

A bill has been instruduced in the House of Representatives of the Congress of the United States by Mr. Dillon of South Dakota and referred to the Committee on Coinage, Weights and Measures and ordered to be printed, the full title of which bill is as follows:

A BILL

"To establish the metric system as the standard for weights and measures, and for "other purposes."

The attitude and animus of the originators and pushers of the bill are sufficiently indicated by section 4, which reads as follows:

"Sec. 4. That any person, corporation, company, society, or association who shall use, or offer and attempt to use, in any industrial or commercial transaction in the sale or purchase of any commodity any other weights or measures than these of the metric system on and after July first, nineteen hundred and twenty-four, shall be guilty of a misdemeanor, and upon conviction thereof in any court of competent jurisdiction shall be punished by a fine of not more then $500 or by imprisonment for not more then three months, or by both such fine and imprisonment."

This shows how times have changed. Here surely is progress. Time was when, in the Old World, a crime of the magnitude here suggested would have been punishable by hanging or decapitation. But this is the New World, the Twentieth Century, the United States of America

RIGHTS OF WEIGHERS AND MEASURERS

In the current discussion of the metric system, as is always the case, the secondary function of the system is accorded undue importance. Weights and measures are primarily for weighing and measuring, and the weighers and measurers should have the first right to say what they shall use for their work. It happens, however, that, although the physical workers of the world, the actual weighers and measurers, outnumber the recorders and computers perhaps a hundred to one, and in the multiplicity of operations in which weighing and measuring occur a thousand to one, they are not the talkers and writers, and so their views and wishes are not presented and defended as they should be, and too often are turned down without a hearing when offered.

The typical and most persistent advocate of the metric system is, after all, only a secondary user of it, the college professor, who never works on Saturdays, who has various vacations in between, with three months in the summer and his sabbatical year for rest and recuperation. Surely he should be relieved from the brain-fag which accompanies the handling of feet and inches, pounds and ounces, cubic feet and gallons, and he is not backward about saying so, but the worker might tell him that it is very little of his business, anyway.

Our workers are not ignorant of the characteristics of the metric system. They know full well that it is not as "scientific" as it claims to be, that it is a scientific failure in not providing facility of continued subdivision by two, and especially by three, which is often so necessary in actual work, and so they prefer, and are likely to continue to use, in their work and in their intimate and most numerous trading, the systems which are most convenient to them.

Just now the argument most persistently urged for the adoption of the metric system—compulsory, of course, for it has never been generally adopted anywhere by free choice—is that it would be an important and valuable feature in securing trade with the metric countries. Every manufacturer and every trader has absolute liberty even now to work to the metric system and to use it in any of his transactions. There is no evidence that one cent of foreign trade has been lost by his failure to do so, and if he has failed to get the metric trade, who is to blame?

This foreign-trade argument might be urged in the opposite direction by ardent protectionists. By all means let us retain our present "incongruous and unhandy" weights and measures, to deter the manufacturers of the metric countries from producing goods to meet our markets. How much have Germany and France been troubled about our weights and measures when seeking our trade or that of England? The argument is equally absurd when urged in either direction.

The attempt to cram the metric system is more than anything else an outcropping of a familiar human trait. It is orthodoxy, or my doxy, trying to down heterodoxy or your doxy, so that we may pat ourselves on the back over it. There are no substantial pecuniary interests to be served except in opposition. —FRANK RICHARDS, *Evening Post, N. Y.*

THE CRACKING OF THE HYDROCARBONS

The following we take from Bulletin 114 recently issued by the Bureau of Mines. Its full title is: Manufacture of Gasolene and Benzene-Toluene from Petroleum and other Hydrocarbons, by W. F. Rittman, C. B. Dutton and E. W. Dean, with a Bibliography compiled by M. S. Howard. There are 268 pages with many illustrations. It embodies a large amount of careful work, is a valuable addition to our stock of technical information and should be of great value to workers and investigators in the line which it carries

ORIGIN AND DEVELOPMENT OF CRACKING PROCESS.

The cracking process, so-called, may be said to date from its accidental discovery at Newark, N. J., in the year 1861. Essentially it consists in heating oils to such a temperature that their heavy molecules decompose into lighter molecules with the production of mixtures of lower boiling point.

FIRST APPLICATION OF CRACKING PROCESS.

As originally employed, the process was directed toward the conversion of that fraction of crude petroleum intermediate between the burning of kerosene oils and the lubricating oils into liquid hydrocarbon products of lower density and boiling point, which would be suitable for use as illuminants. An

open still was used, so that partial condensation of the vapors could occur in the upper part of the still permitting more heat to be supplied to the boiling liquid, with consequent increase in its temperature and the desired decomposition into products of lower boiling point.

CHEMICAL NATURE OF CRACKING PROCESS.

The cracking process is simply one instance of the well-known tendency of organic substances to decompose on the application of heat. The heavier the hydrocarbon molecule, the more easily it is dissociated. In actual fact, cracking to a greater or less degree is the rule rather than the exception in the majority of distillation processes involving more than moderately low temperatures. In 1868 it was pointed out that, during the distillation of hydrocarbons on a commercial scale, cracking always takes place to some degree.

A natural hydrocarbon oil, or crude petroleum, is a mixture of substances of varying boiling points. Each of the hydrocarbons of high boiling point contained in such mixtures is, during the process of distillation, exposed to various degrees of temperature below its own boiling point, so long as the hydrocarbons of lighter gravity and boiling point are not removed from the still. Consequently, the liquid hydrocarbons of high boiling point may remain exposed in the still to temperatures below their boiling point for a number of hours. For example, in refinery practice, one to three days is necessary to complete a crude distillation, the exact period depending on the size of the still and the amount of hydrocarbons to be treated. This long exposure to a degree of heat below the boiling point of a particular hydrocarbon, resulting in its dissociation or partial alteration, constitutes "cracking." As time is an important factor in every organic reaction, the technical significance of the time the oil is exposed to heat becomes evident.

TEMPERATURE AND PRESSURE.

In the cracking of heavy oils two factors govern largely the course of the reactions that take place, namely, temperature and pressure. The function of increased temperature is to break the bonds of groups that make up the complex hydrocarbon molecule. In many processes pressure is of chief importance in controlling the temperature of distillation, but it also exerts an influence on the nature of the decompositions produced.

The temperature at which dissociation takes place with the desired rapidity is usually above the boiling point of the hydrocarbons concerned. When no pressure is employed these hydrocarbons will vaporize and pass out of the reacting sphere, the degree of alteration being small. If, however, sufficient pressure is employed to raise the boiling point to a temperature causing more rapid cracking, alteration into desired products may be obtained with a minimum of total decomposition. As soon as the action begins to be total decomposition, permanent gases will be evolved and both carbon and heavy asphaltic bodies will remain as residues. The volume of gas, therefore, if measured, is an approximate index of the degree of decomposition that is taking place.

OBJECT OF CRACKING PROCESS.

The cracking process involves, therefore, a partial alteration or dissociation, as distinguished from a more complete alteration or decomposition. The object of cracking is to alter the heavier molecules so that low-boiling hydrocarbons will be produced that would not appear on ordinary distillation. Such a process may or may not be accompanied by an appreciable production of permanent gases, depending on the degree of alteration necessary to obtain the desired products. In a simple cracking process as high a temperature as is practicable within the limits of the apparatus is desirable, in order to insure a high speed of reaction. A decrease in temperature below a given point will mean a decided increase in time. In commercial practice this would mean increase in operating costs. On the other hand, too high a temperature will mean a large production of extreme decomposition products, so that for results desirable commercially a mean temperature must be chosen that will cause the process to be completed at the maximum speed consistent with a relatively small production of permanent gases and carbon. This consideration has been emphasized by Engler and Hofer, who point out that, for the splitting of heavier petroleum hydrocarbons into lighter products, excessively high temperatures are not advantageous.

COMMERCIAL VALUE OF CRACKING PROCESS.

Liquid-phase cracking processes, though extensively used for the production of illuminating oils and motor fuels, are as yet in the primary stages of commercial application. As a means of supplying the products most in demand, their importance can hardly be overestimated. They served their purpose well for producing burning oils, when these were the most desirable products, and are now being adapted to the production of gasolines and naphthas. It only remains to discover the most efficient means of obtaining the maximum possible percentage of the desired product from any particular oil. The ease and cheapness with which crude petroleum can be transported to regions lacking supplies of crude oil give particular value to cracking processes, as the cheapest and most readily obtainable oils may be subjected to cracking at the place of the greatest demand and most extensive use.

LATEST DEVELOPMENTS IN BLASTING WITH LIQUID AIR*

The first experiment with liquid air as an explosive dates back nearly to the beginning of its industrial production. Prof. von Linde made an explosive called "Oxyliquit" by mixing liquid air with charcoal. This explosive broth, or paste, was put directly into the drill hole and fired by means of cartridges and fuses.

Since this primitive method gave unsatisfactory results, it was modified by filling a suitably prepared cardboard cylinder with an explosive substance, preferably by dipping the whole in liquid air. This method gave results, but was lacking in safety, and depended on the skill of the workmen and quickness of manipulation. The trouble was due largely to the enormous difference in temperature between the liquid air and the surrounding rock, so that the air rapidly evaporated in the hole. The maximum theoretical life of a blasting cartridge was thus only 10 minutes, while in practice it was still shorter.

Interesting experiments have been made in France by Georges Claude, and other experiments which improve upon the von Linde method have been conducted in Charlottenburg, Germany, by Kowatsch, with the co-operation of von Baldus.

In order to prevent a rapid evaporation of the liquid air, Kowatsch puts the cartridge with the dry carbon container in the drill hole before introducing the liquid air, and avoids the dangerous loss of time by necessary preparations, such as tamping the hole after the mixture has been made. The liquid air is not introduced until time for shotfiring. This reduces the evaporation period to a minimum.

The cardboard cylinder contains a perforated partition tube, in which is placed a perfectly innocuous mixture of infusorial earth and oil or asphalt, or of soot and paraffin. The central partition tube encloses a cardboard tube, over which is thrust another cardboard tube to serve for carrying off the evaporation product of the liquid air. If several holes are to be fired at once, the electric wires are connected.

The liquid air intended for each hole is provided in a suitable quantity in a small flask, to the opening of which is attached a metal tube with a conical point, into which tube is introduced the central tube of the cartridge. To charge the cartridge, it suffices to raise the back end of the flask. The liquid air is then lifted by pressure of its evaporation products (just as water containing gas is lifted by pressure of carbonic acid) in the metal tube, and is forced into the cartridge. At the moment when the shot is fired by an electric fuse, the liquid air combines with the components of the charge and causes an explosion of extraordinary energy.

*From an article by M. Przyborski, mining inspector, Budapest, Hungary, in the *Montanistische Rundschau.*

A NEW INGERSOLL-RAND TURBO BLOWER

The Ingersoll-Rand Company has added to its Turbo Compressors and Blowers a low pressure machine to handle volumes from 3,000 to 35,000 cubic feet per minute at from 1-2½ pounds. These are particularly adapted to such service as foundry cupola blowing, atomizing oil for oil burners, supplying blast to heating and annealing furnaces of various kinds, blowing air for water gas generators, pneumatic conveying and ventilating. They are of the single stage, double flow type, and are furn-

ished either electric motor, steam turbine or water wheel driven. Electric drive is generally employed for the classes of service above mentioned, and the high operative speed permits direct coupling to motor, a first cost economy. The motor driven I-R Turbo blower maintains constant pressure, while delivering any volume from zero to maximum demand and proportionately varying the electrical horse power input.

These blowers embody the four-bearing construction featured in all the Turbo machines of this make. The casing is horizontally parted for convenience in installation and inspection. The assembled casing is doweled and bolted to a heavy sub-base, which ordinarily serves for both blower and driving element. The I-R Turbo occupies small floor space and its vibrationless operation obviates the necessity for foundation bolting. The impeller is of the enclosed double flow type, claimed by the manufacturer to secure the highest efficiency. The wheel is machined from a solid, special steel forging. Vanes and covers are of pressed steel securely riveted. All rivet heads are driven flush and the entire assembly polished. Every care is taken to reduce skin friction. All impellers are overspeeded in a testing machine to insure correct balance, strength and eliminate vibration. Impellers are keyed to a heat treated, forged steel shaft. Labyrinth packing is employed to prevent leakage between impeller and casing. Bearings are ring oiled and both bearings and their housings are parted horizontally.

The use of flexible couplings between blower and driving unit is standard practice on all I-R Turbo Blowers. Machines are all of the closed intake type. The intake openings is at the bottom and discharge at the top.

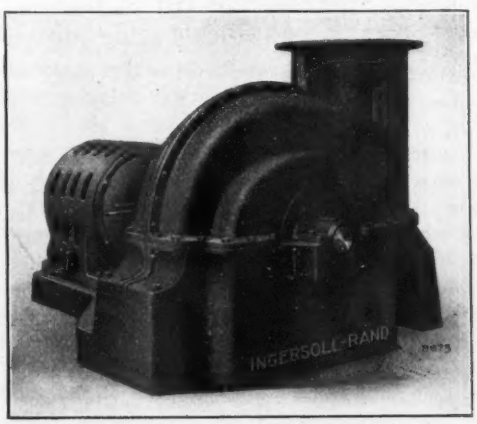


FIG. 1.

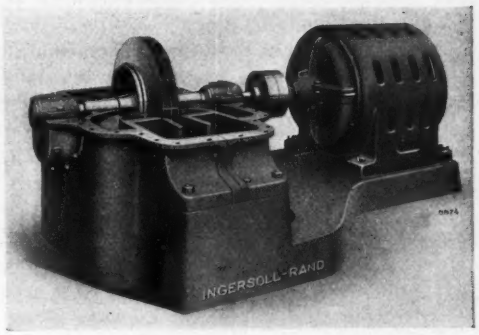


FIG. 2.

The flow of air from this type of blower is absolutely uniform, avoiding all pulsations, which makes it especially desirable for foundry work. The manufacturer emphasizes the fact that there are no rubbing surfaces in the I-R Turbo Blower and points out that this precludes the necessity for adjustment to take up wear and minimizes the cost of maintenance. It is to be noted that the only lubrication necessary is that of the bearings, all other parts working without friction. Fig. 1 shows a low pressure turbo blower complete and Fig. 2, taken from the opposite corner, shows the same machine with the upper portion of the casing removed.

RAPID SPREAD OF THE PNEUMATIC TIE TAMPER

Pneumatic tie-tamping machines have reached a high state of development in the two years they have been in commercial use. They are now a standard track tool in the maintenance-of-way department of many steam and electric railways. Hand tamping did well enough in the past, but in this day of labor shortage the semi-mechanical method is more desirable. As an indication of the status of this method, the Pennsylvania Lines East alone have 150 [216 by the latest count. Ed. C. A. M.] of these tampers in service, according to the Ingersoll-Rand Co.

Air tampers can be operated from pneumatic signals or other air-power lines. Pneumatic signal lines are usually at 110-lb. pressure, but

the switches will operate satisfactory on 60 lb., allowing ample leeway for a drop in presure from any cause whatever. The Pennsylvania operates tampers on these air lines and experiences no difficulty from lowered pressure, although as many as four tampers have been used at one point. Where air is not available, a self-propelled compressor-car is provided. This is built in two sizes—for two tampers and four tampers respectively. The power is furnished by a gasoline engine. The maximum speed loaded is 15 mi. per hr. On electric street and interurban railways power usually is obtained by the use of a motor-driven compressor, mounted for coupling to a work-car or a regular street-car. Whenever a large number of tamping machines are required, as in laying new track, a standard steam or electric-driven compressor can be installed in a work-car.

Portable compressor plants of two- or four-tool capacity cost from $2,000 to $2,500 each, making a rather large investment for only one class of work. These power plants, however, can also supply air for such purposes as boring spike-holes, tightening bolts, drilling and reaming bolt-holes and bond-holes in rails, driving rivets and chipping metal in steel-culvert, bridge and cattle-guard work, tamping earth around culverts, driving plug drills in rock excavation, operating pumps, hoists, jacks, concrete mixers, etc.

Tamping bars for different thicknesses of face are provided for tamping the various kinds of ballast. The thickest tamping bar is that used for cinders, earth, gravel, sand or chat. The thinnest head is for rock ballast of 2-in. mesh or larger. The bars in each case are 18 in. long, with a face 3 in. wide.

The "Imperial" tie tamper weighs 37½ lb. Its best operating pressure is 65 to 75 lb., its consumption at 70 lb. being 16 cu. ft. of free air per minute. The two-tool "Imperial" gasoline-engine-driven compressor-car weighs 2,000 lb. (without hose or tampers). It is 9 ft. 9 in. by 5 ft. 7 in. in plan by 5 ft. 6 in. high and will carry 12 men with equipment. The air capacity is 45 cu. ft. of free-air piston displacement per minute. The gasoline consumption at full load is 1¼ gal. per hr. The tank capacity is 15 gal.—*Eng. News.*

LEYNER DRILL SHARPENER OPERATED BY A CHINAMAN.

THE WORLD'S MECHANICAL KINSHIP

No matter how the world's workers may differ as to race, language, habit, location or environment they can all appreciate the modern devices for mechanical accomplishment and are adopting them the world over. The little half-tone above reproduces a photo of a Leyner rock drill sharpener operated by a Chinaman at the Tul Mi Chung Mine, Korea, Mr. A. Alec. Jones, mine surveyor, who sends the photo, gives no further information except the somewhat superfluous item that the sharpener gives the mine superintendent entire satisfaction.

NOTES

In using heavy and extra heavy iron or steel piping for the great pressures sometimes called for in compressed air practice it should be remembered that the outside diameters of such piping and the threading of the fittings do not change, the extra thickness being secured by the reduction of the internal diameter, so that to get a sufficient area for the flow of the air it is sometimes necessary to use the next larger nominal size of pipe.

It is claimed that the falling off in efficiency shown in the afternoon by laboring men is due in large measure to eating a cold lunch at noon. For this reason some contractors are beginning to experiment with containers designed to keep hot the lunches and drinks of their men.

A lately developed use of compressed air is for the cleaning of furs previous to their storage for the summer. A nozzle is used with a very minute opening, preferably a thin elongated slit. This is run carefully over the surface of the fur to dislodge dust, eggs, etc., which it does effectively and without injury.

It is computed that the horse-power of gasoline internal-combustion engines in the United States is more than twice that of all engines in the country driven by steam. The former include 2,225,000 automobiles, 300,000 motorboats, 45,000 motor-trucks, and 30,000 farm-tractor engines.

James T. Myers, of Callam Bay, Wash., blasted a ditch 3,270 feet long and averaging 2 feet, 10 inches deep, with dynamite in 17 days without help, reclaiming a number of acres of land. It carries off the water formerly flooding the land and has required no shoveling out of caved sides of the ditch since it went into operation.

An important discovery has been made along the lines of scientific progress in Sheffield, in the introduction of stainless steel. As this material will not stain or rust, no matter how it is used, it is particularly adapted for knife blades, which retain their original bright surface. That knives made of this steel will have a large sale no one now questions, but the development of this new branch of the steel industry has been seriously handicapped by the war.

Nails driven in wood that is exposed to alternate wetting and drying are liable in time to start to work out. The wetting swells the wood and increases its dimensions across the grain, and as the nail is inelastic it is moved, a space forming at the point equal to the amount of swelling of the wood. When the timber dries the nail does not return to its original place, and if tapered it tends to move outward each time that wood is wet and dried. It is for this reason that wood structures bolted together and exposed to the weather require screwing up at intervals.

It has been pointed out (Bull. sci. pharm. 1914, 463) that tincture of iodine is incompatible with mercury chloride. Now that iodine is used so widely as a first aid disinfectant for wounds, it is important to remember that the use of mercury perchloride dressings applied afterwards is dangerous, owing to the formation of mercury iodide, which is strongly irritating. Iodine and mercury dressings should never be used together. In cases where mercury iodide has been formed the best method of removing it is to wash the wound with 10 per cent. solution of potassium iodide.

With the increasing use of acetylene gas the risks of its corrosive effect on pipes and metal containers should be better known. Tests have shown that most acetylene, as generated, attacked zinc, lead, brass and nickel to a slight extent; iron was affected six to seven times as much; but copper suffered more than any other metal tested. Copper was quickly changed into a soft, porous black mass. Tin, aluminum, bronze, german silver and solder were practically unaffected. Thus it would appear that copper and brass or other copper alloys should not be used as piping for acetylene-gas supplies, and that iron should be well tinned rather than galvanized or nickel plated.

A rare ceremony took place recently at Wirksworth, Derbyshire, England, when the grand jury of the Ancient Great Barmote Court of the Soke and Wapentake of Wirksworth was summoned to give away the lead mine known as the Dinah, in the Liberty of Wirksworth, to three claimants, one of whom was a Manchester man. The award was strictly in accordance with the ancient lead mining laws of the Peak, which prescribe that when a mineowner fails to work his mine to the satisfaction of the Barmaster (an official of the Royal Duchy of Lancaster), any person may hand in a claim for the property. Formal notices are then posted near the mine for three weeks, and if the mine is not then being worked satisfactorily the award takes place to the new claimant.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MARCH 7.

1,174,105-6. ELECTROPNEUMATIC BRAKE. WALTER V. TURNER, Edgewood, Pa.

1,174,193. PNEUMATIC STARTING MECHANISM FOR INTERNAL-COMBUSTION ENGINES. GREOGORY J. SPOHRER, East Orange, N. J.

1,174,536. APPARATUS FOR INDICATING CHANGES IN ATMOSPHERIC PRESSURE. MARTIN ALBRECHT, Frankfort-on-the-Main, Germany.

1,174,616. VACUUM CLEANING APPARATUS. JULIUS SCHIRRA, Pittsburgh, Pa.

1,174,631. APPARATUS FOR SEPARATING GASES. WALTER O. SNELLING, Pittsburgh, Pa.

1,174,667-8. PROCESS OF FIXING NITROGEN AND ELECTRIC FURNACE FOR EFFECTING THE SAME. JOHN E. BUCHER, Coventry, R. I.

1,174,676. VACUUM VALVE-TUBE. EUGENE W. CALDWELL, New York, N. Y.

1,174,807. PNEUMATIC ACTION. WILLIAM G. BETZ, Buffalo, N. Y.

1,174,905. SPRAYING-MACHINE. AUGUST C. SEEGER, East St. Louis, Ill.

1,174,919. GLASS-BLOWING APPARATUS. ALBERT C. WILCOX, Wheeling, W. Va.

MARCH 14.

1,175,006. APPARATUS FOR ADMINISTERING LIQUID ANAESTHETICS. FREDERIC MONTGOMERY, New York, N. Y.

1,175,050. SPEED INDICATOR AND RECORDER. LONGFELLOW J. DAFT, Issaquah, Wash.

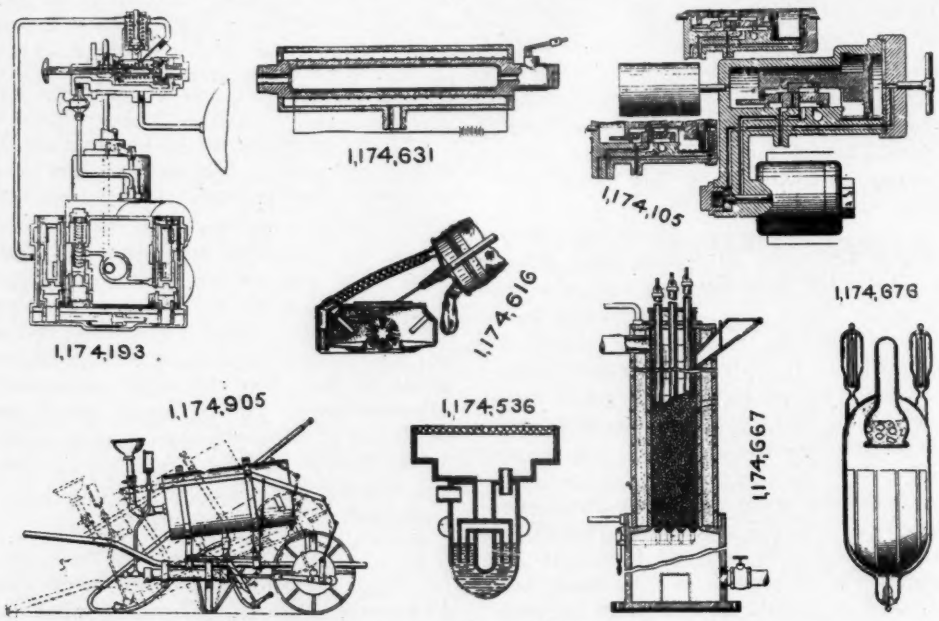
In a speed indicator and recorder, a revoluble shaft, a pump operable by the revolution of the shaft to compress air, a tank to receive the air when compressed, a revoluble indicator disk carrier, a cylinder, a piston in said cylinder, a pencil carrying arm operatively connected with said piston, a spring normally urging said piston in one direction, and a pipe connecting the tank and cylinder whereby to force said piston against the action of said spring.

1,175,053. ELECTROPNEUMATIC BRAKE. JAMES S. DOYLE, Mount Vernon, N. Y.

1,175,097. FLUID-OPERATED GEAR-SHIFTING DEVICE. FRANK L. WALTER, Dayton, Ohio.

1,175,484. APPARATUS FOR COMPRESSING AIR OR OTHER GAS. FREDERICK WILFRID SCOTT STOKES, London, England.

1. In apparatus for compressing air or other gas the combination of a compressor cylinder having an inlet through which both high and low pressure gases enter, a low pressure suction valve, a valve for the high pressure gas and



PNEUMATIC PATENTS MARCH 7.

electro-magnetic means for keeping such high pressure gas valve closed during the required period.

1,175,620. AIR-BRAKE SYSTEM. FRANK H. DUKESMITH, Pittsburgh, Pa.

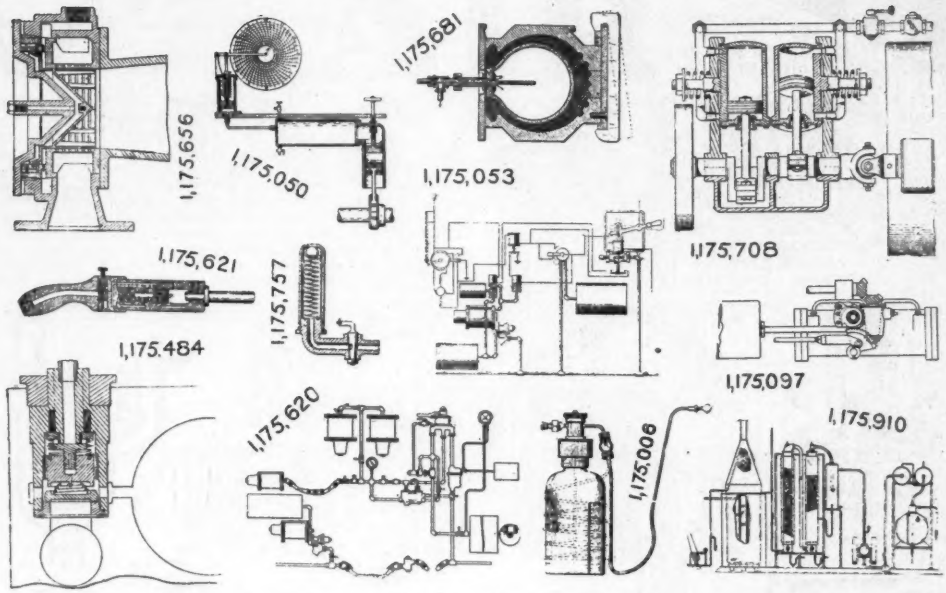
1,175,621. IMPACT-TOOL. CARL EKBERG, Everett, Wash.

1,175,656. SOUND-PRODUCING DEVICE FOR FOG-SIGNALING, POSITION - LOCATING, OR THE LIKE. JOHN PELL NORTHEY, Toronto, Canada.

1,175,681. PNEUMATIC-TIRE APPARATUS. GEORGE ELLINWOOD BATCHELLER, New York, N. Y.

1,175,693. PROCESS OF PRODUCING TUNGSTEN. CARL BOSCH and ALWIN MITTASCH, Ludwigshafen-on-the-Rhine, Germany.

1. The process of producing tungsten which consists in reducing a pure tungsten compound with hydrogen at a moderate temperature and



PNEUMATIC PATENTS MARCH 14.

under pressure above that of ten atmospheres.

1,175,708. AIR-STARTER FOR INTERNAL-COMBUSTION ENGINES. FRED E. CLINE, San Diego, Cal.

1,175,745. DRILLING APPARATUS. GEORGE H. GILMAN, Claremont, N. H.

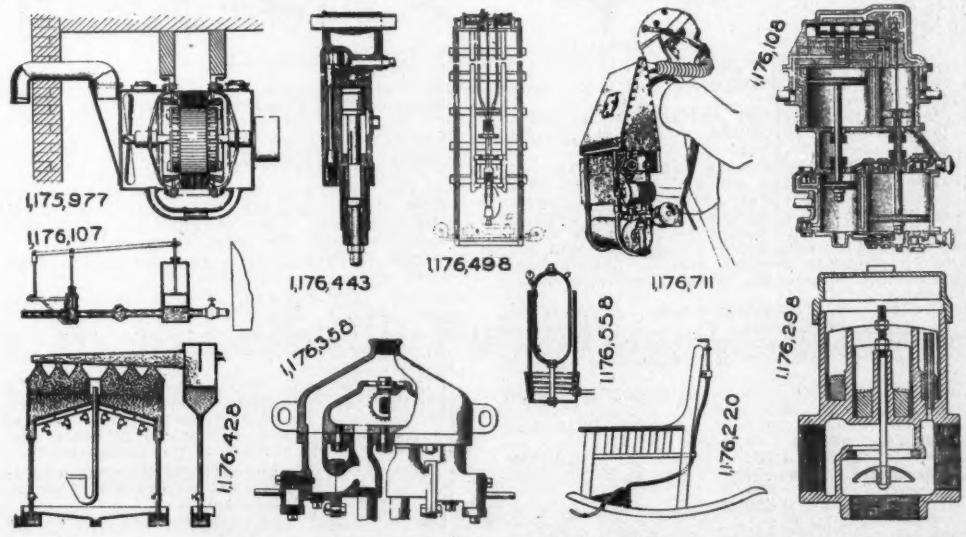
1,175,757. AUTOMATIC AIR-SUPPLY DEVICE. BYRON D. HATHWAY, Woolstock, Iowa.

1,175,876. METHOD OF TREATING MILK. GEORGE SINCLAIR, St. Paul, Minn.

2. The process of pasteurizing milk consisting in gradually heating to approximately 150 degrees F., passing sterile air over, about, and up through the milk during said heating operation, cooling and incubating such milk, and finally flashing to near the death point of the *B. acidi lacti* contained therein.

1,175,910. PROCESS OF MAKING MOTOR-FUEL. WILLIAM AUGUSTUS HALL, New York, N. Y.

4. Process of producing from mineral oil, liquid fuel suitable for use in automobile engines, consisting in cracking the oil under pressure to produce gases and vapors, expanding such gases and vapors, then subjecting such gases and vapors to sudden increase of pressure sufficient in amount to produce an endothermic reaction therein, while the gases are in a heated state, condensing the products so formed and clarifying the product.



PNEUMATIC PATENTS MARCH 21.

MARCH 21.

1,175,977. COOLING SYSTEM FOR ELECTRIC MOTORS. JOHN WILLIAM NOLAN, Pawtucket, R. I.

1,175,979. PRESSURE-GAGE. JOHN F. O'CONNOR, Chicago, Ill.

1,176,107. AUTOMATIC DEVICE FOR CUTTING OFF THE FLOW OF AIR THROUGH OIL-PIPES. THOMAS A. TUCKER, Burkburnett, Tex.

1,176,108-9. FLUID-COMPRESSOR. WALTER V. TURNER, Edgewood, Pa.

1,176,220. AUTOMATIC CHAIR-BLOWER. ANTONI KACZMASZKY, Piper, Ala.

1,176,293. GAS-PRESSURE REGULATOR. ROBERT L. HIBBARD, Sewickley, Pa.

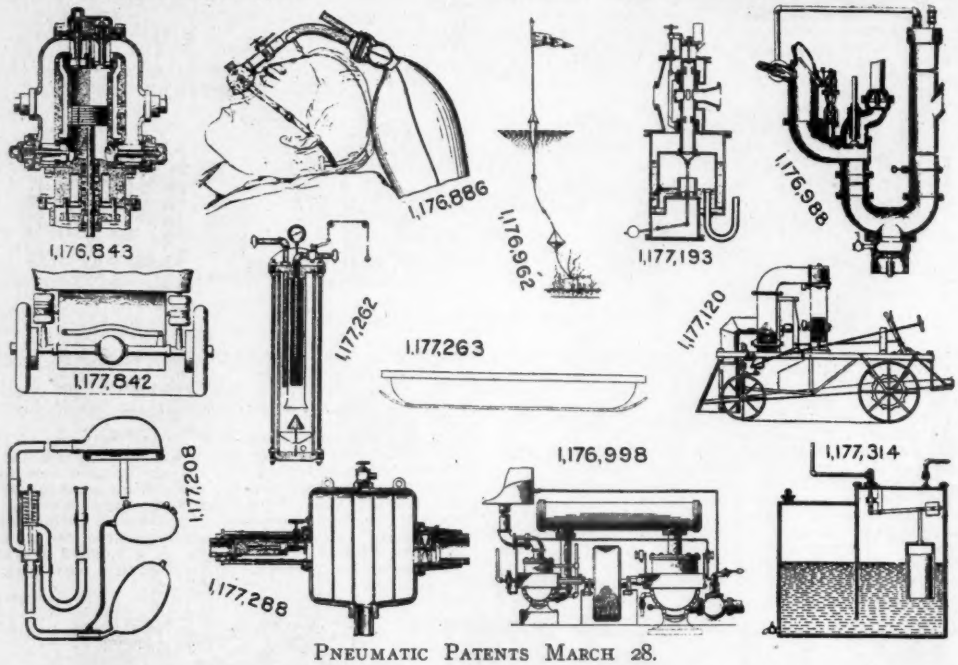
1,176,886. INHALER. GEORGE ERMOLD, New York, N. Y.

1,176,962. WHISTLE-BUOY. WILLIAM A. HEYER, Milwaukee, Wis.

1,176,988. PUMP. CHARLESV H. RITTENHOUSE and WILLIAM E. HALLETT, Phoenix, Ariz.

1. In apparatus of the class described, the combination of a play pipe, an explosion chamber, an intake for the play pipe, means for supplying air to said chamber during each outstroke of the water in the play pipe, means for injecting fuel into said chamber whereby an explosive mixture is formed therein, means for igniting said mixture, and means whereby the burnt gases are exhausted from said chamber on each instroke.

1,176,998. AUTOMATIC REGULATOR FOR



PNEUMATIC PATENTS MARCH 28.

1,176,358. TRACK-SANDING DEVICE. JOHN GAPP, Scranton, Pa.

1,176,428. FLOTATION SEPARATORY APPARATUS AND PROCESS. JOHN M. CALLOW, Salt Lake City, Utah.

1. In flotation separatory apparatus, the combination with a tank adapted to contain comminuted ore and water and a frothable agent, said tank having a bottom restrictedly open to the atmosphere, and means for producing a suction in said tank to draw air through said bottom to generate bubbles and to destroy said bubbles and remove the mineral particles floated thereby.

1,176,443. PERCUSSIVE TOOL. CHARLES H. HAESELER, Philadelphia, Pa.

1,176,498. GLASS-MAKING PROCESS AND APPARATUS. LINCOLN A. THORNBURG, Arnold, Pa.

1,176,558. AIR-COOLING APPARATUS. JOSEPH HOLLENBURGER, Shiner, Tex.

1,176,708. ROCK-DRILL. ALBERT BALL and THOMAS OFFICER, Claremont, N. H.

1,176,711. MINE BREATHING APPARATUS. WILLIAM E. GIBBS, New York, N. Y.

MARCH 28.

1,176,843. COMPRESSOR. JOHN B. LUKOMSKI and ANTHONY LUKOMSKI, Detroit, Mich.

AIR-COMPRESSORS. ARTHUR WARD and THOMAS FRANKLIN PENCE, Webb City, Mo.

1,177,120. COTTON - PICKING MACHINE. THOMAS MANNERS, Waterloo, Okla.

1,177,142. PNEUMATIC-CUSHION STRUCTURE. HERBERT F. RUDD, Chicago, Ill.

1,177,193. DEVICE FOR MEASURING AND FOR REGULATING THE FLOW OF FLUIDS—LIQUID OR GASEOUS. HENDRICK MATHYS LIESE, Hamburg, Germany.

1,177,208. PULMOTOR. JURIAH HARRIS PIERPONT, Pensacola, Fla.

1,177,262. AIR-FILTER. LEWIS GRANT O'DONNELL, Coscob, Conn.

1,177,263. PNEUMATIC RUNNER FOR VEHICLE-SLEDS. JOCELYN EMILE OLLIVIER, St. Gervais, France.

1. A runner for vehicle-sleds comprising a frame, a flexible runner blade, and an intermediate elastic member adapted to be inflated with gas and to exert a uniform pressure over the entire bearing surface of the runner blade.

1,177,288. AUTOMATIC AIR-EJECTING APPARATUS FOR HEATING SYSTEMS. EDWARD R. TELLER, JR., Westwood, N. J.

1,177,314. GAS - PRESSURE REGULATOR. BERNHARDT MATHIAS GATTERMEIR, California, Mo.